THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 18 SEPTEMBER, 1939 Number 9

FREDERICK CARDER

See page 343 for story of Mr. Carder

The Best West of the Rockies

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  English and American
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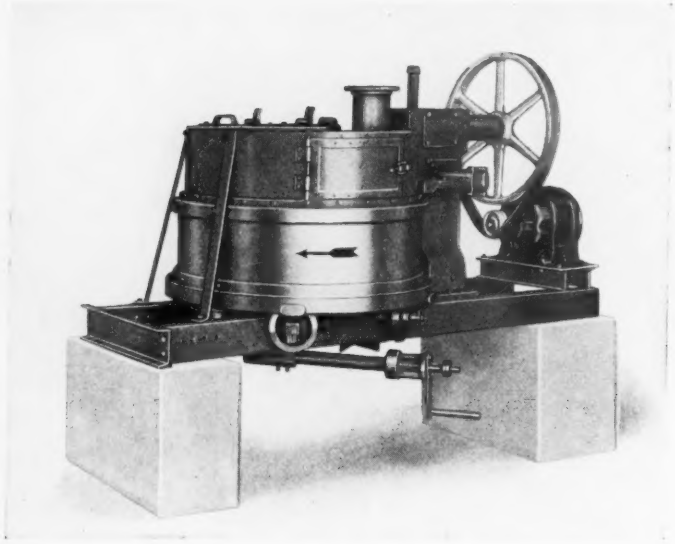

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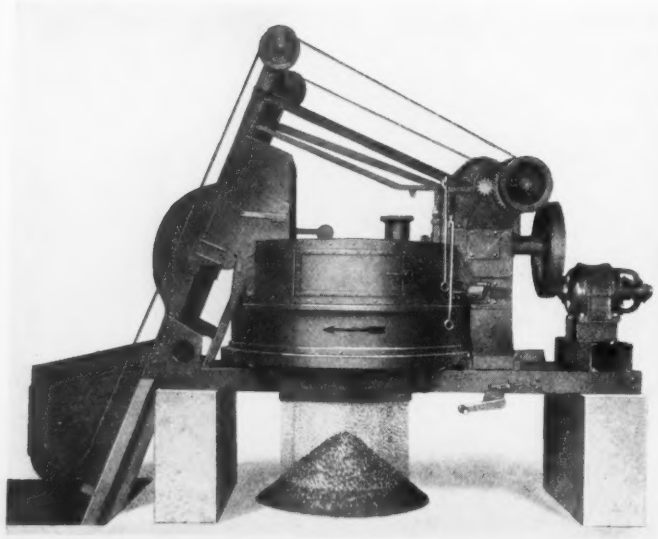

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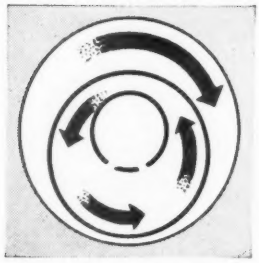

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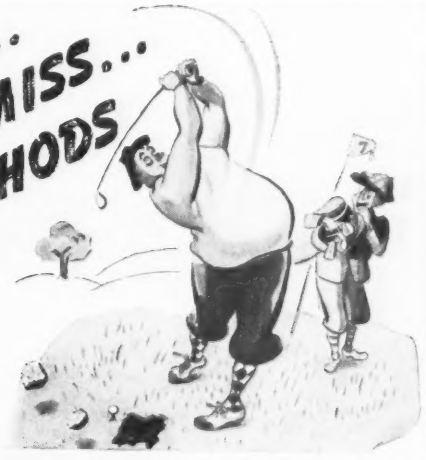

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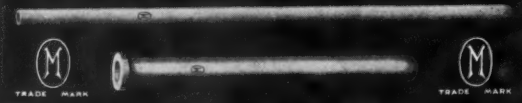

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Spinks, H. C., Clay Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Fire)
Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
United Clay Mines Co.

Clay (German Vallendar)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.

The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Clay (Micronized)
Porcelain Enamel and Mfg. Co.

Clay Miners
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Potters)
Denver Fire Clay Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Process Equipment)
Lancaster Iron Works, Inc.
National Engineering Co.

Clay (Sagger)
Georgia Kaolin Co.
Great Lakes Foundry Sand Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay-Slip (Albany)
Hammill & Gillespie, Inc.
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Wall Tile)
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Cleaners
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.

Cleaners, Chemical
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Clocks (Gauge Board)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cobalt Sulphate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Colors
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Concrete (Chutes, Grouters)
Ransome Concrete Machinery Co.

Cones
The Edward Orton, Jr., Ceramic Foundation

Conveying Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.

Copper Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Corhart
Corhart Refractories Co.

Cornwall Stone (Imported)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

Crucibles (Filter, Melting, Ignition)
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Potters Supply Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Cryolite (see Kryolith)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Frazier-Simplex, Inc.

Cutters (Bar)
Ransome Concrete Machinery Co.

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Disintegrators
Lancaster Iron Works, Inc.
National Engineering Co.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.

Electrocast Refractories
Corhart Refractories Co.

Enamelers' Borax
Porcelain Enamel and Mfg. Co.

Enameling Equipment (Complete)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Lancaster Iron Works, Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.
Bethlehem Steel Co.

Enameling Muffles
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Frazier-Simplex, Inc.
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Enamel Oxide
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
The Hommel Co., O., Inc.

Exhaust Systems
The DeVilbiss Co.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Filter Fabrics
Metakloth Company

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Norton Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Spinks, H. C., Clay Co.

Flint
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Great Lakes Foundry Sand Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.

Flint Pebbles
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Floors (Non-Slip)
Norton Co.

Fluorspar
Harshaw Chemical Co.
The Hommel Co., O., Inc.

French Flint
Maxson, Elwyn L.
Paper Makers Importing Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Frosting Mixtures
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Fuel Oil Systems and Control, Stokers
Bethlehem Steel Co.
Frazier-Simplex, Inc.

Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Furnaces, Enameling
Swindell-Dressler Corp.

Glass Bending Ovens, Glass Decorating Machines
Frazier-Simplex, Inc.

Glass Equipment
Hartford-Empire Co.
Lancaster Iron Works, Inc.

Glass Melting Tanks and Furnaces
Frazier-Simplex, Inc.

Glass Sand
Great Lakes Foundry Sand Co.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.

The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

Goggles
The Hommel Co., O., Inc.
Willson Products, Inc.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Granulators
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

Hearths
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Hoppers (Floor, Tower)
Ransome Concrete Machinery Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Hydrofluoric Acid
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Iron Chromite
Harshaw Chemical Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kilns, China (Decorating)
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Kilns- (Electric, Circular, Tunnel)
Swindell-Dressler Corp.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide) (Refractory)
Louthan Mfg. Co.

Kyanite
Celo Mines, Inc.

Kryolith (see Cryolite)
Pennsylvania Salt Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Lehrs
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehrs (Electric or Fuel Heated)
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehr Loaders
Frazier-Simplex, Inc.

Linings (Furnace Refractory, Block Refractory Plate, Brick, and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Norton Co.
The Vitro Mfg. Co.

Lithium Carbonate
Drakenfeld, B. F., & Co.

Loaders (Bucket)
National Engineering Co.

Magnesia (Fused)
Norton Co.

Magnesia (Sintered, Calcined)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Magnesite Calcined
The Hommel Co., O., Inc.

Magnesium Carbonate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese Dioxide
Drakenfeld, B. F., & Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Masks (Breathing)
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Micronized Products
Porcelain Enamel and Mfg. Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers
National Engineering Co.
Ransome Concrete Machinery Co.

Mixers (Batch)
Lancaster Iron Works, Inc.
National Engineering Co.

Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)
Lancaster Iron Works, Inc.
Ransome Concrete Machinery Co.

Mixers (Laboratory)
Lancaster Iron Works, Inc.
National Engineering Co.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Frazier-Simplex, Inc.
Norton Co.

Mullers (Batch)
Lancaster Iron Works, Inc.
National Engineering Co.

Muriatic Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Needle Antimony
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nepheline Syenite
Great Lakes Foundry Sand Co.

Nickel Salts
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Nitre
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.

Pins (Tile Setter)
Louthan Mfg. Co.

Placers (Concrete Pneumatic)
Ransome Concrete Machinery Co.

Placing Sand
Great Lakes Foundry Sand Co.
United Clay Mines Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Polariscopes
Bausch & Lomb Optical Co.
Frazier-Simplex, Inc.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Potters Wheels
Denver Fire Clay Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Frazier-Simplex, Inc.

Pug Mills
Lancaster Iron Works, Inc.

Pyrites (Natural Iron Sulphide)

The Hommel Co., O., Inc.

Pyrometer Tubes
Carborundum Co.
Montgomery Porcelain Products Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.

Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation

Racks, Firing (Refractory)
Louthan Mfg. Co.

Raw Material Handling Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

Refractometers
Bausch & Lomb Optical Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.

Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.
Titanium Alloy & Mfg. Co.

Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
Willson Products, Inc.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal and Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Salt Cake
American Potash & Chemical Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Sandblast Helmets
Willson Products, Inc.

Sandblast Sand
Great Lakes Foundry Sand Co.

Sand Grinder and Sifters
Lancaster Iron Works, Inc.

Saponin
The Hommel Co., O., Inc.

Screening and Magnetic Separators
National Engineering Co.

Selenite of Sodium
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Setters (Tableware)
Louthan Mfg. Co.

Sheaves (Tower)
Ransome Concrete Machinery Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Harshaw Chemical Co.

Silicon Carbide
Carborundum Co.
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Denver Fire Clay Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sodium Metasilicate
Harshaw Chemical Co.

Sodium Nitrite
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Sodium Uranate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Soot Blowers
Frazier-Simplex, Inc.

Special Machines
Frazier-Simplex, Inc.

Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Spray Booths
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spraying Equipment
The DeVilbiss Co.
The Hommel Co., O., Inc.

Spurs
Louthan Mfg. Co.
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Stilts
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
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Tank Blocks
Corhart Refractories Co.

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Norton Co.

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Metal & Thermit Corp.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
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The Vitro Mfg. Co.

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Montgomery Porcelain Products Co.
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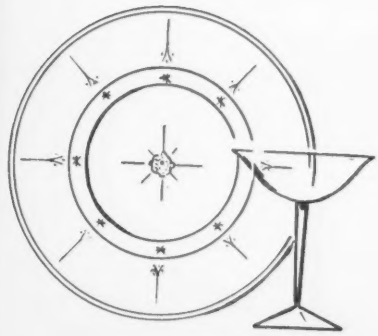

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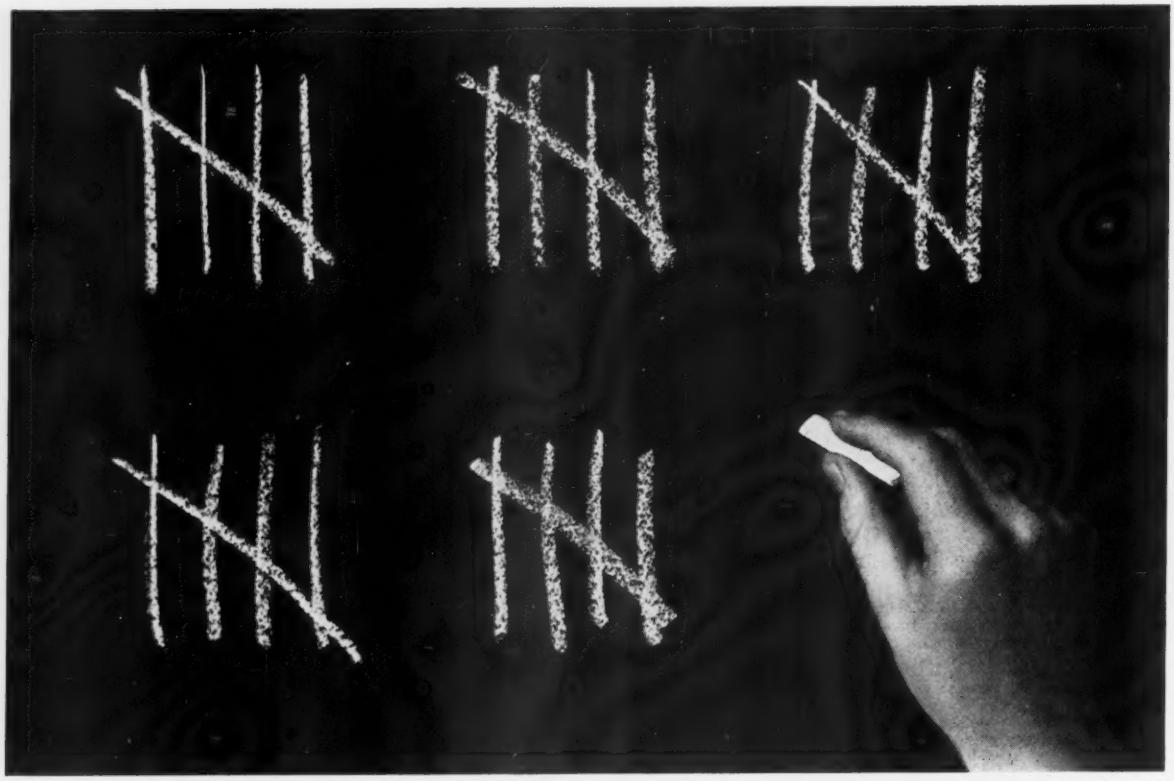

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PAPERS

SYMPOSIUM ON "IMPROVED PROCESSING AND CONTROL METHODS FOR CERAMIC RAW MATERIALS"*

I. CONTROLLED MIXING

By E. M. Rupp

I. Introduction

This discussion deals with mixing plastic bodies having a moisture content of 9 to 27%. All elements of the mix are proportioned by weight into a muller-type batch mixer, with the proper amount of liquid added; they are mulled until a complete distribution of the clays and dispersion of the liquid is accomplished. The amount of the various ingredients comprising the body, the amount of liquid, and the mulling time are controlled, which insures a close adherence to the requirements of the batch as well as strict uniformity in each succeeding batch. The process is not "dry mixing" but "controlled mixing" of the wet plastic bodies.

II. Operation of Controlled Plastic Mixing

As experience has progressed, the necessity (1) to provide an effective mulling action to overcome balling, (2) to accomplish thorough distribution, and (3) to develop the required plasticity when using different types of clay has become increasingly apparent. Plastic bodies, which contain from 22 to 27% moisture and disintegrated or air-floated clays, are mixed thoroughly in a stationary large-diameter pan with heavy mullers adjusted to a desired height from the pan bottom. Plows are used to clean both the periphery and the bottom of the pan and to fold or roll the bottom materials over and under the mullers, and mullers are fitted with scrapers and offset so that a shearing or spreading action is imparted to the material under pressure as the mullers pass over it. The liquid is added to the mixture by spray nozzles, which revolve with the cross-head and spray the liquid under pressure on to the body ingredients as they are turned over ahead of the mullers. The materials, after being properly mulled, are discharged through an opening in the bottom of the pan.

The total mixing time has been found to vary from 12 to 25 minutes per batch, depending on the types of clay used and whether they are disintegrated or air-floated. One to three minutes of the total mixing time is usually necessary to mix and to disperse the plastic and nonplastic ingredients uniformly so that the tendency to ball will be reduced when the liquid is added.

If the moisture content of the body is high enough to jigger the ware, it is possible to use disintegrated clays instead of air-floated clays, although a somewhat longer total mixing time is required than when air-floated clays are used. Where disintegrated ball clays are used and their total content is not too high, it is possible to have a small blunger and lawn located near the mixer so that the operator may add a ball-clay slip to obtain the ball-clay content and the moisture required.

An important factor to be decided in considering controlled mixing for plastic or jiggered ware is the method for rehandling scrap materials. The scrap is worked up as a separate batch in some cases because it is necessary to reintroduce only the correct moisture, the various ingredients having already been thoroughly mixed.

The scrap materials may be used in casting or by blunging, lawning, and adding the slip of scrap to obtain the correct moisture content. This indicates that a certain definite amount of scrap would be used in each batch produced.

The method of procedure after the body has been discharged from the mixer depends upon the individual plant; some have found it advisable to run the pre-

* The papers included in this Symposium were presented at the Autumn Meeting of the Materials and Equipment and White Wares Divisions, Bedford Springs, Pa., September 16 to 17, 1938. F. P. Hall was the presiding officer at this Symposium. The Program Committee was Harry Thiemecke, *Chairman;* and Ralston Russell, Jr., and W. W. Meyer. The papers were received November 22, 1938.

pared mix through a deairing pug mill to form deaired bats for jiggering; in other plants, the lumps which are discharged from the mixer are taken directly to the jiggering room. The pressure of heavy mullers on the materials tends to drive out the entrapped air and produces a product which is considerably compacted as it is discharged from the machine, thus for many purposes making the use of a deairing machine unnecessary.

III. Conclusions

One plant has been working on jiggered bodies successfully for one year. The body preparation is kept much cleaner than in the slip method; the labor to mix the body is greatly reduced; the power consumption is less; and the length of time of material in process is greatly reduced.

National Engineering Company
Chicago, Illinois

II. NOTES ON PREPARATION OF AIR-FLOATED CLAYS

By R. C. Meeker

Several years ago the producers of ball clays were asked for finely ground clays for use with dry-mixing equipment for the production of a number of different types of ware which had previously been made by the usual blunging, lawning, and filter-pressing methods. The manufacturers of dry-pressed ware were among the first to ask for finely ground clays, but the dry-mix method of body preparation is also applicable to plastic methods of forming the ware.

The producers of ball clays were confronted with three major problems in the preparation of finely ground clays, *viz.*, (1) handling crude clays through all stages of preparation to insure cleanliness and freedom from impurities; (2) drying so that economical grinding would result without impairing the plastic properties of the clays; and (3) selection of equipment to give a uniform, relatively clean product.

These notes describe how these problems were met as well as the procedure used to produce air-floated ball clays.

The ball clays, which are hand-selected and classed in the mine, are placed in special bins so arranged as to keep out contamination and to remove part of the mine moisture. From the special bins, the clay is moved in lump form to a preliminary disintegrator which reduces it to a convenient size for feeding to the mill. The clay passes on a conveyer belt to the mill over a magnetic pulley which eliminates contamination in the form of tramp iron.

The mill is a roller-type combination drying and grinding unit. Heat for additional drying in the grinding chamber is provided by a stoker and furnace operating in conjunction with a heat exchanger to keep the products of combustion from the mill and system. The hot air from the heat exchanger passes through spun-glass filters which act as an additional safeguard to the cleanliness of the finished product.

The actual grinding is done by four rollers suspended in a vertical position on arms which extend horizontally from the vertical shaft. As the shaft revolves, the rolls turn against a bull ring, and the clay is squeezed and broken up. The rollers and the bull ring are made from special alloys having wear-resisting properties.

The finely ground clay is removed by a stream of controlled air from the grinding chamber to a classifier and air separator. The coarse particles drop to the bottom of the double cone-shaped separator; they are returned to the mill to be ground to proper size, after which they are carried to two cyclone collectors operating in series. The collectors feed the clay to loading chutes, where it is bagged to a definite weight per bag or loaded in bulk in cars which are paper-lined and covered. No air-floated clay is carried in stock in bulk owing to the possibility of contamination.

Water is carried off in vapor form from the last cyclone collector along with a quantity of dust. The system is exhausted into a bubble tank where the dust is arrested.

The entire installation is electrically driven and controlled throughout. The system operates under a partial vacuum which registers in a glass tube connected to the mill. The rise and fall of the colored liquid in the tube, according to the overloading or underloading, either obstructs or allows the passage of the light beam to the feed box. The automatic feed controls not only keep the mill fully loaded at all times but they influence the uniformity of finished product from the standpoint of screen analysis.

Hot air enters the mill at a temperature of 700°F. There is a drop in temperature through the grinding chamber to 120°, and the finished product is delivered at about 100°F. This heat treatment has no apparent effect on the properties of the clay. Trial runs have been made with an entrance to mill temperature of 1000°F and a delivery temperature of 275°F.

There are three controls which regulate the fineness of product, *viz.*, (1) the velocity of air through the mill is important; (2) the vanes, set at the top of the air separator, which regulate the swirl of the current of air and clay (the vanes may be adjusted simultaneously either parallel to the normal flow of clay or nearly at right angles, as desired); (3) the pipe connecting the air separator and the first cyclone collector has an adjustable sleeve by which it may be lowered or raised in the separator; when the end of the pipe is extended to the lower part of the separator, coarser particles are picked up, and they are eliminated from the finished product by raising the pipe end to the top of the air separator.

With these controls, the product may be changed from a 60- to a 300-mesh product, although no attempt has been made to grind and air-float to 300-mesh. A typical dry-screen analysis of ball clay suitable for dry-

mix tile and porcelain bodies is as follows: on 80-mesh 4.5%, on 100-mesh 5%, on 150-mesh 9%, on 200-mesh 10%, and through 200-mesh 71.5%.

The moisture content of the finished product will average between 3 and 5%, depending on the grade of clay and its properties. Each ball clay has its own peculiar drying and grinding characteristics. There is also a difference in the weight of individual clays that can be packed in a bag of a given size; some clays have a greater tendency to bulk up than others ground to the same grain size.

The successful use of air-floated ball clay in the dry-mixed bodies depends on the cleanliness of the clay and on the type and quantity of residue ordinarily caught on the lawn. If both the clay and its residue fire relatively clean and if the wet lawn residue is not too highly carbonaceous and so hard that it will not slake and smear readily, no difficulties should be encountered, assuming that the clay gives the desired properties when used in blunged and filter-pressed bodies.

KENTUCKY-TENNESSEE CLAY COMPANY
ALLIANCE, OHIO

III. APPLICATION OF DRY-MIX PROCESS IN PLASTIC BODY PREPARATION

BY F. A. FIX

I. Introduction

The results of the great amount of work already completed, as well as the experiments and tests that are now being carried on, indicate the definite possibility of the application of the dry-mixing process for plastic ceramic body preparation.

II. Test Studies

First Group

The ball clays and Georgia kaolin were air-floated in the first tests. The ball clays were ground; a small percentage was as coarse as 60-mesh and about 50% was finer than 200-mesh. The remainder of the materials was ground to minus 200-mesh.

The mixing procedure followed in these tests consisted of placing all the dry ingredients in the mixer with the plastic materials "sandwiched" between the nonplastics. These ingredients were dry-mixed four minutes.

The exact amount of water was added to the dry-mixed batch to produce the desired plasticity, and the wet-mixing operation was extended for six minutes.

A pug mill for deairing was used to obtain the necessary results in these tests.

The many tests made at this particular plant show that all the requirements, fulfilling those of the regular wet-processed ware, were met, including workability, straightness, shrinkage, absorption, weight, modulus of rupture, autoclave test, and appearance.

Second Group

Subsequent tests for vitreous and semiporcelain ware were made using seventeen different formulas. Each of these formulas contained materials from different sources. Practically every source of ceramic material was represented in these tests. The purpose was to determine the comparative value of the various materials from the standpoint of physical qualities and appearance in the finished ware.

Good physical results were obtained in all tests. The samples showed a close-knit and homogeneous mix. Some of the test samples had a better appearance than others. This difference may be traced to insufficient or improper drying, insufficient oxidization, and/or a variation in the cleanliness of the ceramic materials.

The same general mixing procedure was followed as with the first group of tests. All of the dry materials were introduced in the mixer and were dry-mixed for five minutes; all the water was added within three minutes, after which the batch was wet-mixed for seven minutes.

All of the domestic and foreign ball clays as well as the Florida and Georgia kaolins were air-floated. The remainder of the ceramic material was ground approximately to 200-mesh.

Third Group

These tests were made at a chinaware plant. The dry-mixing equipment was installed at the plant and about one ton of material was prepared. The same general mixing procedure was followed as on the second group of tests. Air-floated clays were used.

The finished ware was satisfactory, and the results were as follows: (1) The workability on the jigger tables was satisfactory; the jiggermen liked the uniform plastic condition of the body; the moisture content was uniform; and the necessity of reworking the body in the pug mill was eliminated. (2) The ware came from the kiln with less than normal warpage. (3) The absorption was normal. (4) The quality of ware was the same (both processes compared). (5) The dry-mixing method gave the body more strength and improved the body structure. (6) The ware produced by the dry-mixing process was as clean as with the wet process, and there was no tendency to spot on the dry-mixed body. (7) The system is simple; material may be prepared for the jigger within an hour; it now takes two days to get wet-processed material through the slip house.

Fourth Group

The clays used in these tests were pulverized locally to about 200-mesh. They were not air-floated, and the results indicated that air-floated materials were unnecessary. (1) A cleaner body was produced by this process. (2) The water was added slowly after all the dry ingredients had been mixed.

(3) A definite improvement was noted in dry strength and fired strength. (4) A reduction in absorption was also noted.

III. Summary

The following conclusions may be drawn from these tests:

(1) Clean air-floated clays are essential where cleanliness is required.

(2) When industrial ceramic products are made from plastic bodies, the ground clays are sufficiently fine.

(3) The clays that are clean, soft, and take up water readily need not be air-floated. They do not require preliminary mulling, and they may be added with the other dry ingredients into the mixer.

(4) Because of the fluffiness of the materials used in dry mixing, efficient pugging equipment is essential to obtain a dense clay body.

(5) Physical qualities equal to the wet process are obtained.

(6) The body preparation is greatly simplified with dry mixing.

(7) The producers of ceramic materials have spent considerable sums of money to produce the high quality of materials available today, and there is definite improvement in the cleanliness of these prepared materials compared to those previously available.

Lancaster Iron Works, Incorporated
Lancaster, Pennsylvania

IV. NOTES ON PLASTIC MIXING

By H. Frahme

The plastic mixing of stoneware bodies has been accomplished by mixing the raw materials which have been well blended dry or semidry, with the proper quantity of water.[1]

The present method of body preparation consists of blunging the clays and fine-grained nonplastics with sufficient water to produce a slip of minimum water content consistent with proper fluidity for screening and filter-pressing. The slip is pumped over a vibrating screen and filter-pressed. Because of the plastic nature of the clays used, both the blunging and the filter-pressing operations are somewhat slow. In the case of filtering, it is necessary to use pressures as high as 225 lb. per sq. in. to secure firm cakes within a reasonable time limit. The coarser nonplastics are mixed dry, spread between the filter cakes, spaded, and fed to a pug mill for further mixing. The moisture content is adjusted by adding water in the pug mill.

Although this method of preparation has been quite satisfactory over a period of years, the elimination of the slip process would have certain advantages, especially from a cost standpoint. A Lancaster SKG unit was obtained on a three-month rental basis for tests. This mixer was equipped with a 5-h.p. motor and fitted with a tank from which the necessary quantity of water could be added during the mixing cycle. A small laboratory stirrer was attached to the water tank to keep the barium carbonate additions in suspension.

A number of 50-lb. batches of a standard stoneware body were prepared, using both pulverized and air-floated clays with varying barium carbonate additions. All clays were the same as those used in regular production except for their degree of fineness.[2]

The entire batch was introduced to the pan of the mixer at one time and mixed dry for two minutes. The water with barium carbonate in suspension was added during a 9-minute mixing period, and the plastic body was mixed for an additional two minutes. The total mixing time therefore was 13 minutes. The 9-minute mixing period was determined by the time required for the water to run by gravity from the tank through a small-diameter glass tube leading to the mixing pan. If a more rapid method of adding the mixing water had been used, the mixing cycle could readily have been reduced to about ten minutes.

Several batches were prepared with different moisture contents covering the range of plastic consistencies used in regular production.

Each batch was tested for dry strength, and samples were prepared for fired strength and water absorption. Similar tests were made with a standard production body to obtain direct comparisons between the two methods of mixing.

The body prepared in the Lancaster mixer in each case possessed considerably higher dry strength. The average increase in transverse strength was 35.1%. This is considered to be a most important improvement because high dry strength is necessary in the manufacture of large, complicated pieces of stoneware.

This method of mixing had little effect on the fired strength of the material, which amounted only to about 5% increase.

A rather important improvement was noted in the water absorption, which was reduced from 1.2 to 0.30%. The improved dry strength and water absorption were thought to be caused largely by the elimination of air from the material mixed in the Lancaster. The wedging action of the mullers on the plastic mix seemed to eliminate a large proportion of the air from the body. The samples made from the body prepared in the ordinary way were not deaired.

Several pieces of ware were fabricated from the material prepared in the Lancaster mixer. These

[1] Practically all the mixing of the various raw materials must be accomplished before sufficient water is added to render the batch plastic.

[2] The pulverized clays were ground in a Mikro pulverizer through the courtesy of the Pulverizing Machinery Company; the air-floated materials were processed by the United Clay Mines Corporation.

pieces were dried and fired in the customary manner. No difficulties were encountered in making these pieces; they were discharged from the kiln in excellent condition, and they had fewer and smaller iron spots on the surface. While freedom from specking is not of paramount importance in the manufacture of stoneware, it is desirable to minimize these blemishes. This improvement in appearance is attributed to the increased fineness of the iron-bearing impurities in the pulverized and air-floated clays.

No noticeable difference was found between the bodies prepared from pulverized clays and those prepared from the air-floated materials. It is unnecessary to go to the added expense of air-floating for stoneware production.

If this type of mixer is installed for regular production, it may be operated in either of two ways. The body may be prepared to the desired moisture content in the mixer and discharged to an auger machine for extrusion into convenient blanks for handling. A better procedure, however, would be to add only a portion of the water in the mixer and the remainder in the present pug mill. This would increase the capacity of the mixer and reduce the power requirements. In the latter case, the batch would be discharged from the mixer when plasticity begins to develop. The material in this condition would probably discharge from the mixer more rapidly and would be easier to handle because the softer consistency tends to ball up into rather large lumps.

In addition to the preparation of plastic bodies, this experimental unit was also used to prepare several batches of casting slip. The mixer handled the casting slip easily, requiring only about 15 minutes to prepare a batch which ordinarily requires 1½ hours with the present equipment.

This method may be expected to have the following advantages as compared with the present procedure: (1) an improved body through increased dry strength, decreased water absorption, and fewer iron specks; (2) greater uniformity of mixing between clays and nonplastics; (3) elimination of much equipment, such as blunger, screens, pumps, and filter presses; and (4) greater flexibility of equipment in changing over from one body to another. There is less material in process with this method and fewer pieces of equipment in use. This is important when several different bodies must be prepared with the same equipment.

In considering these advantages, however, the following factors must be kept in mind:

(1) All clays must be air-floated or finely pulverized, which increases the raw materials cost considerably.

(2) All impurities in the clays must remain in the body as there is no opportunity for their removal. This disadvantage is not serious in this plant. The soluble salts, which are present in the clays and are partially removed in filter pressing, may be handled satisfactorily with small additions of barium carbonate. The larger particles of iron-bearing impurities, which are ordinarily removed from the slip by screening, are finely pulverized with the clays and are not objectionable in this degree of fineness.

General Ceramics Company
Keasbey, New Jersey

V. NOTES ON FRACTIONATION OF CLAYS AND PRODUCTS RESULTING THEREFROM

By S. C. Lyons

Ceramists have been intrigued for a long time by visions of making better ware by using raw materials of controlled particle size and so apportioning the various constituents, particularly the clays, that intelligent control of the voids in the fired structure would be predetermined, somewhat as the properties of concrete aggregate are determined.

It seems reasonable to assume not only that the properties of the ware might be improved, such as the strength, dielectric values, freedom from mechanical strains and imperfections, but that the uncertainties of production might also be diminished, such as extended firing ranges, better control of shrinkage, and simplification of glazing problems. These thoughts are offered as suggestions rather than as demonstrated facts.

Little significant experimental work could be done to test this idea until recently because clays, feldspars, and other minerals of controlled particle size were not readily available.

In fact, simple, practical methods suitable for control purposes to evaluate the particle-size distribution of clays, etc., only recently have become generally available. Most of the older and relatively empirical methods, such as sieve tests and bulking tests, commonly used heretofore to compare the fineness of clays are quite unreliable.

Not only were methods of evaluating the fineness of clays inadequate, but the conventional methods of refining them did not lend themselves to ready and precise control.

Production of uniform particle fractions from natural sources of raw materials whose particle-size distribution almost inevitably varies from one section of the deposit to another was practically impossible. All that could be done was to remove most of the really coarse material, such as mica, quartz, and pyrite, and hope that the natural variations in the relative proportions of the finer particles would be "ironed out" by blending the slips in large tanks or the finished clay in large storage sheds. Rather good results in uniformity may be obtained in this way if the storage facilities are sufficiently large, but few or no fractionation tests can be made.

During the past five or ten years, however, conditions have been fundamentally changed. Radically new and

effective processes and equipment have been developed by the leading American clay refiners. It is now possible to prepare a slip from a Georgia kaolin and to resolve it into a series of two or more fractions under controlled and reproducible conditions. Each of these fractions is of a different and substantially uniform average particle size, but each will vary one from the other in several properties. The coarser fractions generally tend to have extremely low shrinkage and low green and fired strength; they form slips of low viscosity and are easily adaptable to casting purposes owing to their rapid drainage. The finest fractions, on the other hand, are very plastic, with high green strength and high shrinkage, and they are too colloidal to cast readily. They resemble the ball clays and Florida clays in many respects although they are produced from a different type of crude kaolin.

TABLE I

Particle size (micron)	Sample No. (%) (A)	(B)	(C)	(D)	(E)	(F)	(G)
2	47.3	64.5	71.6	97.1	16.6	No	47.3
2–3	16.5	9.0	9.3	1.5	11.9	data	16.5
3–4	5.2	4.7	8.3	1.4	2.2		11.9
4–5	5.2	3.6	4.1	0.0	0.0		10.8
5–6	6.2	5.2	2.1	0.0	19.7		8.3
6–7	4.6	1.6	2.1	0.0	0.0		3.1
7	15.0	11.4	2.6	0.0	49.6		2.1

It is possible that some aberrations in the dry-strength data (Table II) may be the result of minute cracks formed in the specimens owing to the progressively higher shrinkage of the finer fractions. It is also interesting to note that the surface conditioning of the particles of the fine intermediate fractions, (F) and (G), shows a marked effect on the strength and shrinkage of the specimens. Sample (F) was electrically flocculated; sample (G) was flocculated with alum; but the two samples were of identical particle size.

As in the case of the unfired specimens, there is a general tendency, with minor exceptions, for the fired modulus and shrinkage to increase with the fineness of the clay. As in the green samples, the surface condition of the particles may affect these values to a marked degree (see samples (F) and (G)).

The fractionations are made by passing the slip through continuous-flow centrifuges of relatively new and special construction. They are usually operated in series and in such manner that the solids-depositing conditions in each stage are maintained at a uniform value. It is believed that these new centrifugal methods are superior to the older gravity methods for the same reasons that have caused cream separators to supplant the old-time pan and skimmer.

TABLE II

Sample	Dry strength (lb./sq. in.)	Linear drying shrinkage (% dry basis)
(D)	385	6.95
(C)	301	6.16
(B)	334	5.82
(A) (crude)	372	5.59
(F) (electro-flocculated)	210	5.15
(G) (alum-flocculated)	170	4.38
(E)	126	5.26

(A) = original crude clay.
(B) = original clay after removal of grit, mica, etc.
(C) = clay after removal of coarse intermediate fractions.
(D) = clay after removal of fine intermediate fractions.
(E) = coarse intermediate fraction.
(F) = fine intermediate fraction (electrodewatered).
(G) = fine intermediate fraction (filtered with alum).

TABLE III

FIRED STRENGTH AND TOTAL LINEAR SHRINKAGE

Sample	Fired strength (lb./sq. in.)	Linear firing shrinkage (% dry basis)	Absorption (%)
(D) (finest)	877	2.03	19.0
(C)	347	1.91	20.7
(B)	348	0.85	18.7
(A) (crude)	363	0.84	18.9
(F) (electro-flocculated)	299	1.16	21.1
(G) (alum-flocculated)	210	0.94	22.9
(E) (coarsest)	168	0.84	24.1

Some of these machines have been in operation almost continuously for more than three years, and it has been established beyond question that the costs are not out of line with those of less effective conventional methods.

The clay producers and a few of the better-equipped ceramists are developing plans to carry on a coöperative research and development program. The primary purpose of these studies will be to determine a few of the fundamental effects of controlled particle-size components upon the characteristics of ceramic bodies.

GEORGIA KAOLIN COMPANY
DRY BRANCH, GEORGIA

PROGRESS IN PRESTRESSING STRUCTURAL CLAY MASONRY*

By F. O. Anderegg

Abstract

The trend in prestressing is toward lightweight masonry, and when tongue and groove units are used with members assembled with grouting, the deck strength is much greater than the sum of the individual member strengths. The great stiffness of such floors is an outstanding feature. The best results have been obtained with grouted-in rods. Some results of a photoelastic analysis are given, indicating that with adequate steel the strength of the prestressed beam is nearly equal to that of an ordinary reinforced beam plus a value proportional to the amount of prestress on the bottom fiber.

I. Introduction

During the past two years, substantial progress has been made in reducing the weight of roof and floor decks assembled from properly prestressed clay-tile members. The National Fireproofing Corporation has worked out methods of making lightweight units of adequate strength, which have first been assembled into members (either in the factory, at some convenient central location, or on the job) and are of a size suitable for handling by two men. For roofing, these bear the trade name, "Dek-Tile"; when assembled into floors, they are called "Clay-Span" floors. The units are usually provided with tongues and grooves to permit the interlocking members to form a slab of high integrity.

II. Advantages of Prestressing

The advantages of this type of construction[1] are as follows: (1) increased load-carrying capacity due to the prestressing to three or four times the capacity of an ordinary reinforced beam with proper design and selection of materials; (2) stiffness increased about as much as the load-carrying capacity; in one comparison, an unprestressed slab deflected 1 in 360 under a load of 75 lb. per sq. ft.; to produce the same deflection in a similar prestressed slab, more than 200 lb. per sq. ft. were required; (3) assembly of members in a convenient location, where facilities may be provided for an efficient working condition (prestressing is readily controlled); (4) no forms required in the building; (5) load application to the deck immediately or very soon after laying; and (6) fireproof benefits found in all clay-tile construction.

III. Application of Prestressed Units

The application of prestressed roof slabs in the construction of a building for a circular tunnel kiln in East Canton, Ohio, is shown in Figs. 1 and 2. The finished weight of this roof was about 12 lb. per sq. ft. Along with this lightness, there is some reduction in heat transmission, and this construction is resistant to corrosive fumes. Load tests were made on one of the members over a 7-ft. span, and it was necessary to apply about 400 lb. per sq. ft. to deflect one part in 360. For this test, high-quality mortar was used, and end blocks of proper strength were selected to support the ends of the rods. These tile have a depth of about 4 inches.

For floor construction, where higher loads must be supported, the thickness must be increased to 6 inches and the weight to about 25 lb. per sq. ft. per unit. For the first test, one hole has been provided in the center near the top and another near the bottom. Because the latter hole contains the stress rods, it is important to provide a substantial amount of clay around the hole in the end tile to take up the compression.

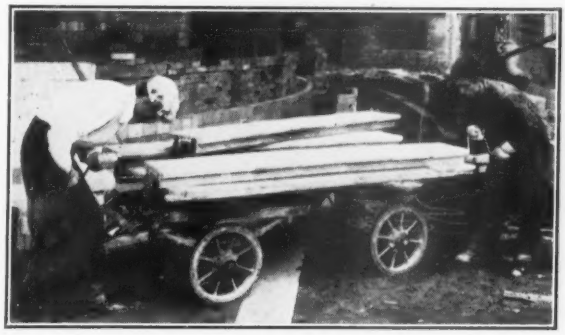

Fig. 1.—Prestressing roof members weighing about 12 lb. per sq. ft.

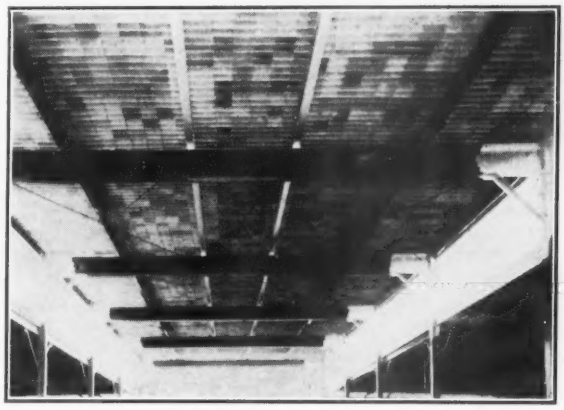

Fig. 2.—Under side of finished roof.

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 30, 1938 (Structural Clay Products Division). Received October 22, 1938.

[1] (*a*) F. O. Anderegg and C. L. Dalzell, "Prestressed Ceramic Members," *Proc. A.S.T.M.*, **35** [Part II] 447–56 (1935); *Ceram. Abs.*, **15** [4] 124 (1936).

(*b*) F. O. Anderegg, "Super-Ceramic Building Members," *Jour. Amer. Ceram. Soc.*, **20** [3] 77–79 (1937).

TABLE I

PRESTRESSED FLOORS

Panel No.	Depth (in.)	Width (in.)	Span (ft.)	Special conditions	Set after (lb./ft.²) 40–50	Set after (lb./ft.²) 100–125	Load (lb./ft.²) to deflect 1/360	Failure (lb./ft.²)
1	6	12	12	5/8-in. rod	0		80	150 (*E*)
2	7	48	12	1-in. topping	0.02		167	230 (*E*)
3	6	36	12	Rods grouted	0.004	0.015	209	375 (*ER**)
4	6	36	12	None	0.001	0.003	132	230 (*E*)
5	7	36	12	1-in. topping	0.007	0.024	177	275 (*C*)
6	7	36	14	1-in. topping	0.011	0.020	136	258 (*C*)

(*E*), crushing at end of tile under washers.
(*R*), rods stretching.
(*C*), tile crushing.

* Panel loaded, with load available to give 275 lb. per sq. ft. and removed, leaving a set of 0.136 in.; two days later reloaded to destruction.

IV. Results of Tests

The results obtained in testing single members, intended for housing with a design loading of 40 to 50 lb. per sq. ft. or assembled into floor slabs, are given in Table I. The slabs were placed on rollers, 1 inch in diameter, but no capping was provided to insure a uniform load across the panel support. At the quarter-points on the top, two steel bars were embedded in the mortar to provide uniform bearing, and rods, 1 1/2 inches in diameter, transmitted the load from a platform on which sand bags could be piled. The deflections to 0.001 inch were noted with two Ames dials. After applying loads of 40 or 50 lb. and of 100 or 125 lb. for each square foot according to design, it was removed and the amount of "set" (permanent deflection) was observed. After the panel had been loaded to about two thirds of its capacity, the dials were removed and deflections were read with a ruler until the slab failed. Loading at the quarter points is equivalent to uniform loading.

Deairing was used in the manufacture of the tile, and coke was mixed with the clay. The crushing strength of the tile with the webs vertical averaged 2652 lb. per sq. in. for the gross area and 5251 lb. per sq. in. for the net area. The absorption after a one-hour boil was 17.7%, corresponding to a void space of about one third. The weight of units was about 22 1/2 lb.

The mortar used in assembling the members was composed of standard Portland cement, Ohio River sand, and fire clay (1 to 2 1/2 to 1/4 parts); for grouting the members together into slabs and for topping, the composition ratio was 1 to 2 1/2. The strength of 2-inch cubes obtained by the Pittsburgh Testing Laboratory for the mortar containing the fire clay averaged 3979 lb. per sq. in. at 7 days and 6562 lb. per sq. in. at 28 days; the grout, with the fire clay left out, produced only 2308 and 3800 lb. per sq. in., respectively.

Reinforcing rods were made of special threading steel, SAE 1120. A rod 3/8 inch in diameter was used in the top, and a 3/4-inch rod (unless otherwise noted) served as stress rod. It was threaded with standard bolt thread, and standard nuts rested on 2 1/2-inch washers, which were bedded with mortar. The threads should be carefully cleaned and lubricated with a graphited grease before putting on the nuts.

The units can be set on end and mortar may be applied by pouring from a can or by trowel. Jouncing the block against the floor would give the mortar a "dilatency" or partial set and permit it to be handled. The units were assembled on a straight plank with the aid of a straight edge, and the rods were inserted and tightened to a reasonable degree at once to compact the mortar and to allow it to harden under compression. Because the joints are usually about 3/16 inch thick, the sand should be screened through a 14-mesh screen. After the nuts are tightened down, the members may be handled with suitable care and, after standing overnight, they may be placed in position.

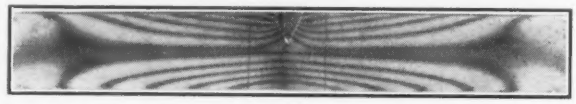

FIG. 3.—Centrally loaded simple beam without prestress; the black dot at which the white lines converge is the neutral "axis"; the sixth tension fringe is just entering at the bottom. The original films show only half the beams; the two sides of the prints are identical.

The grouting of the rod in Panel No. 3 has contributed two effects, *viz.*, (1) it has supplied more material under the end washers and (2) it has gripped the rod tightly so that upon stretching the rod initially, a large part of the stretch occurs in the ends. Later, after the initial compression in the bottom fiber has been neutralized, the center part of the rod receives the greatest part of the tensile load, and because it had not been stretched so much earlier it could take more at that stage. It is believed that prestressing will have an ever-increasing opportunity of speeding up the erection and reducing costs of fireproof modern construction.

V. Photoelastic Analysis of Prestressed Beam

In a previous paper[1(b)], photographs were given of the stress-fringe pattern of a celluloid model obtained with plane polarized light, but no attempt was made at analysis. This work has been repeated[2] with a transparent

[2] In coöperation with Royal Weller of the Ohio State University Engineering Experiment Station, whose assistance is gratefully acknowledged.

phenolic resin model, using circularly polarized monochromatic light.

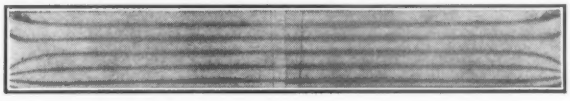

FIG. 4.—Prestressed simple beam without flexural loading; the sixth compression fringe is just entering the beam at the bottom.

FIG. 5.—Prestressed beam loaded in flexure with 65 lb. to neutralize compressive stress in bottom fiber.

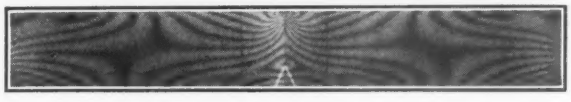

FIG. 6.—Additional loading of 23.8 lb. applied; the third tension fringe has entered from the bottom and about half way to the fourth; $23.8 \times 6/3.5 = 41$ lb., equivalent to six fringes and 44.4 lb., which checks within the experimental error.

Figure 3 is a beam undergoing flexural loading without prestress[3]; Fig. 4 is a prestressed beam without flexural loading, the neutral axis being at the topmost fiber; Fig. 5 is a prestressed beam loaded just to neutralize the compressive stress in the bottom fiber; Fig. 6 shows an additional load applied to put the bottom in tension. The neutral axis is indicated on each photograph. The load required to produce one stress fringe is 340 ± 20 lb. per sq. in., and the accuracy is about $^1/_2$ fringe or 170 lb. per sq. in. The loading and stress data are given in Table II.

[3] Max M. Frocht, "Photoelastic Investigation of Shear and Bending Stresses in Centrally Loaded Simple Beams," *Carnegie Inst. Tech Eng. Bull.* (1937).

TABLE II

RESULTS OF PHOTOELASTIC ANALYSIS OF PRESTRESSED BEAM

Fig. No.	Condition	Load (lb.)	No. of fringes at bottom	Bottom fiber stress (lb./in.²)
3	Flexural load; no prestress	44.4	+6 (*T*)	+2040 (*T*)
4	Prestress only; no flexural load		−6 (*C*)	−1870 (*C*)
5	Prestress; initial compression in bottom just neutralized	65	0	−0
6	More loading	88.8	+3$^1/_2$ (*T*)	+1200 (*T*)

Positive sign and (*T*) = tension; negative sign and (*C*) = compression.

VI. Conclusions

The conclusion to be drawn from these results is that with a beam of proper design (*i.e.*, of proper distribution of compression- and tension-resisting materials) the load-carrying capacity of the beam is equivalent to the prestress plus (approximately) the capacity of an ordinary reinforced beam. In other words, with brittle ceramic materials for a given section and by the use of more and/or stronger steel for tensile reinforcing, appreciable gains in load-carrying capacity are secured. The increase in stiffness is an important advantage in this type of construction.

The published analysis[1(b)] has apparently been confirmed by the photoelastic analysis.

NEWARK, OHIO

INVESTIGATION OF CERTAIN PROPERTIES OF REFRACTORY CONCRETE*

By R. T. Giles

Abstract

The relation of cold strength to strength after heating is shown, and data are presented from which wall strength may be calculated. The development of fired strength begins at 1500°F, at which temperature some of the hydraulic or cold strength remains. The selection of the aggregate is important to the development of fired strength. The effect on the fired strength of the addition of percentages of low vitrification clay to high vitrification aggregates is shown. Data are given on shrinkage.

I. Introduction

The increasing use of concrete made with a calcium aluminate cement for resistance at high temperatures over long time periods has emphasized the need for reliable data to be used for design purposes. Information is also needed on the length of time the specimens should be exposed to a given temperature before testing so that the results may represent the ultimate strength of the concrete under the conditions of exposure. The data presented here have been obtained from an extensive series of tests.

II. Materials and Test Procedure

Cement: The cement is a calcium aluminate.

Aggregates: The six aggregates used were (1) a low vitrification lightweight clay, Haydite, (2) a high vitrification crushed clay (average high-grade fireclay brick), (3) a lightweight insulating diatomaceous earth, (4) a low vitrification Albany slip clay, (5) a high vitrification plastic fire clay, and (6) chrome ore.

Preparation of Aggregate: One part of coarse aggregate was mixed with 1.16 parts of fine aggregate, weighed, and soaked in water overnight before mixing with the cement the next day.

Aggregate gradation

Coarse (mesh)	(%)	Fine (mesh)	(%)
On 4	14.2	On 8	3.7
" 6	41.4	" 10	14.4
" 8	39.0	" 20	24.4
" 10	5.4	" 40	23.4
		" 60	5.7
		" 80	3.7
		Passing 80	24.8

Proportions: The proportions used for the test specimens were 1 bag of cement to 4 cu. ft. of aggregate and 6.75 bags of cement to 1 cu. yd. of hardened concrete (except where noted otherwise or where lightweight compressible aggregates were used).

Specimens: Flexural and linear-change measurements were made on 2- by 2- by 6-in. beams, which were dried at 120°F for the base measurement of linear change. Compression tests were made on 2- by 2-in. cubes.

Curing: Specimens were kept in moist air for 24 hours, dried at 120°F, and ground to size before they were placed in the furnace.

Firing Procedure: The furnace was brought up to test temperature in 12 hours; 24 hours after the furnace reached the test temperature, 3 beams and 3 cubes of each mix were withdrawn and were reported as the 1-day test. Forty-eight hours after the furnace reached the test temperature, specimens were withdrawn, tested, and reported as the 2-day test. The same procedure was followed for the other time periods. The test period for 1000°, 1250°, and 1500°F continued for 12 days; for 1750° and 2000°F, the test period continued for 6 days.

Load Test: Two tests were made for each period on standard 9-in. brick, holding the furnace (1) at the specified temperature for 4 hours and (2) for 12 hours. When no subsidence occurred, flexure tests were made on the brick.

Linear Change: Linear change was determined on all 2- by 2- by 6-in. specimens of each mixture after they were withdrawn from the furnace and cooled to atmospheric temperature. Linear change was also obtained in some cases on specimens heated only on one side.

Compression and flexural tests and load and spalling tests were made in accordance with the A.S.T.M. standard method except for the change in temperature.

III. Mixes and Results[1]

Table I

Mix No. 1 (1 bag cement, 4 cu. ft. Haydite (low vitrification aggregate))

No. of days	Compressive test (lb./sq. in.) Cold strength, 2253 throughout			
	1000°F	1500°F	1750°F	2000°F
1	591	517	441	1911*
2	861	418		
3	975	550	532	977
4	618	413		
5	701	498		
6	592	369	822	1075
7	819	287		
8	673	270		
9	862	356		
10	785	403		
11	732	334		
12	693	423		
Av.	742	403	598	1321

* Individual breaks, 2017, 1952, and 1765.

*Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 18, 1939 (Refractories Division). Received January 5, 1939.

[1] These tests were made under the supervision of Frank E. Lobaugh, New York State College of Ceramics, Alfred, N. Y.

Additional data from other sources are given in Section IV, which may add to or confirm the information given herewith.

TABLE I (*continued*)

No. of days	Flexural test (lb./sq. in.) Cold strength, 711 throughout 1000°F	1500°F	1750°F	2000°F
1	377	181	347	785*
2	340	202		
3	369	219	226	320
4	358	160		
5	338	126		
6	288	110	427	350
7	380	108		
8	378	109		
9	330	122		
10	390	122		
11	427	103		
12	388	154		
Av.	363	143	333	485

No. of days	Linear change (% average shrinkage) 1000°F	1500°F	1750°F	2000°F
1	0.0	0.26	0.08	0.0
2	0.5	0.17		
3	0.5	0.0	0.52	0.17
4	0.25	0.08		
5	0.85	0.52		
6	0.17	0.26	0.69	0.43
7	0.34	0.17		
8	0.68	0.43		
9	0.34	0.26		
10	0.5	0.34		
11	0.5	0.34		
12	0.5	0.52		
Av.	0.43	0.28	0.43	0.20

* Individual breaks, total load, 1100, 1072, and 970.
Av. total load, 1047;

TABLE II

SPALLING TEST ON MIX NO. 1 (1000°F)

Brick No.	Thermal spalling started on 30th dip (% change in weight) Dip No. 30	31	32	33	34	35	36	37	38	39	40
1	+6.0	+6.58	+4.94	+3.66	+1.15	+4.97	−7.42	−7.76	− 8.27	−13.8	−18.45
2	+9.4	+8.5	+8.9	+7.38	+3.35	−3.3	−5.7	−8.4	−11.5	−17.2	−20.9
3	+8.0	+8.1	+7.42	+6.0	+4.0	−0.05	−4.8	−7.3	− 8.1	− 9.3	−12.4
4	+8.6	+8.1	+7.3	+6.9	+4.1	+2.7	+0.8	−2.0	− 4.7	− 9.3	−12.3
5	+9.7	+9.5	+9.2	+8.2	+2.8	−0.6	−5.7	−6.7	− 7.7	−11.0	−12.2
	Volume change (% loss)										
1	1.5	2.9	3.7	5.4	6.5	11.1	12.3	12.3	14.1	19.7	22.2
2	1.7	1.7	2.1	5.4	7.5	13.8	16.6	22.2	25.0	27.7	
3	0.6	0.9	2.3	3.5	7.4	11.1	11.1	11.1	12.3	16.7	18.1
4	0.6	1.4	3.7	4.9	6.7	11.1	11.1	12.3	13.7	16.7	19.4
5	0.9	1.7	2.9	3.4	6.3	13.8	13.8	13.8	16.7	19.4	21.6

TABLE III

SPALLING TEST ON MIX NO. 4

Brick No.	1250°F dip F.S.	F.C.	1500°F dip F.S.	F.C.	1750°F dip F.S.	F.C.	2000°F dip F.S.	F.C.
1	4	8	5	11	3	5	2	
2	4	11	5	11	3	5	2	3
3	4	11	5	10	3	4	2	
4	4	11	5	9	3	5	2	3
5	4	7	5	9	3	4	2	

F.S., dip at which failure started; F.C., dip at which failure was complete.

TABLE IV

	1000°F	1250°F	1500°F	1750°F	2000°F
		Linear change (one side heated)			
Cold face	No test	0.0	0.0	0.0	0.0
Hot face		−0.37	0.0	0.0	0.0
		Load test (% change)			
4 hr.	0.0	−0.35	−0.69	−2.77	−12.6
12 hr.	0.0	−0.35	−1.39	−3.66	−16.0
		Flexural test (lb./sq. in.)			
4 hr.	283	149	198	195	Too badly
12 hr.	361	258	231	204	distorted for test

TABLE V

Mix No.	Compression (lb./sq. in.) Cold strength	1000°F	1250°F	1500°F	1750°F	2000°F
2	1895	879	840	402	585	991
3	1895	698	972	443	777	1351
4	1830	No test	692	426	474	561
X	1434	624	753	965	998	952
Y	576	405	288	387	372	344
M	3125+	No test	No test	640	195	348
N	2333	" "	" "	512	257	461
O	2617	" "	" "	551	258	446
P	3125+	" "	" "	619	272	433
Q	3125+	" "	" "	837	410	741

Mix No.	Flexure (lb./sq. in.) Cold strength	1000°F	1250°F	1500°F	1750°F	2000°F
2	828	376	300	166	246	317
3	828	329	256	210	350	498
4	536	No test	218	155	246	250
Y	693	263	253	277	393	395
X	234	160	146	130	217	206
M	640	No test	No test	176	88	131
N	649	" "	" "	151	131	178
O	762	" "	" "	171	118	166
P	1012	" "	" "	200	154	192
Q	823	" "	" "	226	236	310

The following tests were made at the same time and under conditions similar to mix No. 1. Average results are used for brevity; the number of specimens for each average varies; the fewest number (9 individual test specimens) is the number represented by one average, and 36 is the largest number of test specimens representing one average.

TABLE V (*continued*)

Mix No.	Linear change (% shrinkage) 1000°F	1250°F	1500°F	1750°F	2000°F
2	0.19	0.43	0.46	0.52	0.38
3	0.19	0.39	0.39	0.76	0.17
4	No test	0.21	0.40	0.58	0.71
Y	0.33	0.34	0.52	1.07	0.69
X	0.29	0.40	0.63	3.00	1.39
M	No test	No test	0.24	0.29	0.55
N	" "	" "	0.30	0.37	0.55
O	" "	" "	0.26	0.43	0.52
P	" "	" "	0.19	0.40	0.31
Q	" "	" "	0.11	0.34	0.49

Mix No. 2: 1 bag cement, 4 cu. ft. low vitrification aggregate, and 25 lb. high vitrification clay.
Mix No. 3: Duplicate of mix No. 2, except specimens were saturated after hardening with a 50-to-50 saturated solution of borax and sodium carbonate.
Mix No. 4: 1 bag cement, 4 cu. ft. high vitrification aggregate, and 25 lb. high vitrification fire clay.
Mix Y: prepared mix (furnished); contains roughly 1 bag cement, 4 cu. ft. high vitrification aggregate, and a high percentage of low vitrification clay.
Mix X: prepared mixture (furnished); contains roughly 1 bag cement, 4 cu. ft. diatomaceous aggregate, and a high percentage of low vitrification clay.
Mix M: 1 bag cement, 4 cu. ft. high vitrification aggregate, with nothing passing 100-mesh sieve.
Mix N: 1 bag cement, 4 cu. ft. high vitrification aggregate, with 10% passing a 100-mesh sieve.
Mix O: 1 bag cement, 4 cu. ft. high vitrification aggregate, with 15% passing 100-mesh sieve.
Mix P: 1 bag cement, 4 cu. ft. high vitrification aggregate, with 20% passing 100-mesh sieve.
Mix Q: Same as mix N, mixed very dry and rammed into molds.

IV. Data from Other Sources

No. A (1) concrete[2]: 1 part calcium aluminate cement, 2 parts sand, and 4 parts gravel; 2- by 4-in. cylinders heated 4 hours.

Compressive test (lb./sq. in.) Cold	200°F	300°F	500°F	800°F	1100°F	1400°F	1700°F
7070	2590	2807	1500	1060	993	775	452

No. A (2) concrete mix[3]: high vitrification aggregate with various percentages of Albany slip clay added; 2- by 4-in. cylinders heated at 1800°F for 24 hours.

Compressive test (lb./sq. in.) Cement (g.)	Slip clay (g.)	Aggregate (g.)	Compressive test (av. of 3)
200	0	1000	241
"	50	"	378
"	100	"	521
"	150	"	552
"	200	"	733

No. A (3) concrete mix[3]: chrome aggregates with various percentages of Albany slip clay; 2- by 4-in. cylinders heated 24 hours at 1800°F.

Compressive test (lb./sq. in.) Cement (g.)	Slip clay (g.)	Chrome (g.)	Compressive test (av. of 3)
200	0	1000	543
200	100	1000	698
200	200	1000	856

No. A (4) concrete mix[3]: 1 bag cement, 4 cu. ft. clay aggregate in 6- by 12-in. cylinders, heated at 1660°F for 13 days; average compressive strength, 466 lb. per sq. in. for 10 cylinders.

TABLE VI

PYROMETRIC CONE EQUIVALENT ON REFRACTORY MIXTURES CONTAINING CALCIUM ALUMINATE CEMENTS

(Proportions by Weight)

Parts of materials to 1 part cement (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Cone No.
									6–10
	3								7–8
	4								7–8
	5								7–8
		3							15–16
		4							17–18
		5							23–26
		9							29–30
			4						15–16
			7						16–17
			10						17–18
				3					30–31
				4					31–32
				5					33–34
				9					36–37
					3				20–21
					4				29
					5				30–31
					9				31–32
						4			20
						6			23–26
						8			23–26
							8		7
0		6							20–23
1/4		5 3/4							23
1/2		5 1/2							23–26
3/4		5 1/4							26
1		5							28
2		4							30
		5						0	16
		5						1/4	15
		5						1/2	15
		5						3/4	15

These results are representative and should be used only as a guide (tests from various sources).

The column headings are (1) fused alumina; (2) low vitrification clay aggregates; (3) high vitrification clay aggregates; (4) pottery saggers; (5) chrome; (6) magnesite; (7) olivine; (8) trap rock; (9) Albany clay slip.

V. Standard Load Test at High Temperature

The standard load test shows that refractory concrete, using several percentages of cement and various aggregates, will begin to fail at 2250° to 2300°F, and complete collapse will occur between 2450° and 2700°F. This is due undoubtedly to the liquid phase developed as the fusion point of the cement is reached.

These tests include (1) mixtures of 10 and 20% cement, (2) aggregates of fireclay grog, bauxite, chrome, magnesite, and sillimanite, (3) mixtures of chrome and magnesite, and (4) a mixture containing 20% cement with an aggregate mixture of 70% magnesite and 30% chrome

[2] From "Comparison of High Temperatures on Concretes of Alumina and Ordinary Portland Cement," *Univ. of Washington Bull.*, No. 43, 27 pp., Sept. 15, 1927. Seattle, Wash.

[3] Tests by Atlas Lumnite Cement Co.

preheated to 2825°F. The preheating increased the resistance-to-load bearing properties.

	Test piece failed (°F)
Unfired	2530
Prefired at 2825°F	2700

Reduction in the percentage of cement has less effect.

Cement (%)	Chrome (%)	Test piece failed (°F)
20	80	2550
10	90	2650
5	95	2675

No tests are available on a mixture with a low percentage of cement that has been preheated at high temperatures. These tests apply only to refractory concrete heated on all sides (not when the concrete is heated only on one side).

VI. Discussion

(1) High Cold Strengths

There is little, if any, advantage to be gained by using an excessively high cold strength in concrete that is to be exposed to elevated temperatures. This is illustrated in Fig. 6 on which are plotted the University of Washington tests, No. A (1), with mixes Nos. 1 and 2. It is true that the time of exposure (4 hours) of the A (1) tests may not be so desirable as a longer exposure, which, if it had any effect, would reduce the strength still further after heating.

(2) Structural Strength

Using structurally strong aggregates in the regular mix, the part of the concrete with the lowest strength would have a compressive strength of about 400 lb. per sq. in. and a flexural strength of about 100 lb. per sq. in. The concrete, when exposed to high temperatures on one side only, would vary in strength from the low of 400 to about 1500 lb. per sq. in. on the cold face; on the hot face, the strength would vary with the temperature of exposure and the materials used from no structural strength above 2250°F to as high as 1200 to 1500 lb. per sq. in. for that part of the concrete between 1500° and 2250°F.

Assuming that a wall is exposed to 2000°F on one side and to atmospheric temperatures on the other, the concrete on the inside and outside will have relatively high structural strength and that of the concrete in the middle of the wall will be much lower; the minimum strength is approximately the same whether large or small specimens are used.

Using structurally weak aggregates, both the cold strength and the strength after heating are greatly reduced (see mix X). Little, if any, fired strength is developed at the maximum test temperatures, which is about the limit of exposure recommended for these aggregates (Fig. 2).

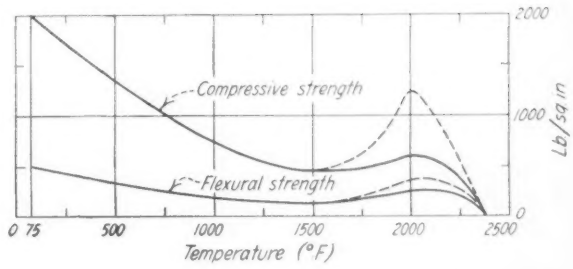

FIG. 1.—Ultimate compressive and flexural strength used to determine the average ultimate strength of concrete slabs or walls exposed to high temperatures for long periods; these results are applicable to concrete, with a cold compressive strength of 2000 lb. per sq. in. or more and with a cold flexural strength of 500 lb. per sq. in. or more, with 1 bag of calcium aluminate cement as the binder and 4 cu. ft. of aggregate. *Dotted line*, low vitrification clay aggregate or low vitrification clay added to high vitrification clay aggregates; *solid line*, high vitrification clay aggregates.

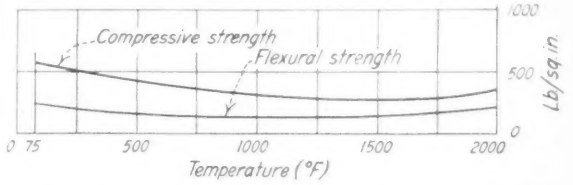

FIG. 2.—Ultimate compressive and flexural strength to determine average ultimate strength of concrete slabs or walls exposed to high temperatures over long periods of time; results are applicable to concrete with cold compressive strengths of 1000 lb. per sq. in. or less with a calcium aluminate cement (4 cu. ft. of weak insulating aggregate to 1 bag of cement).

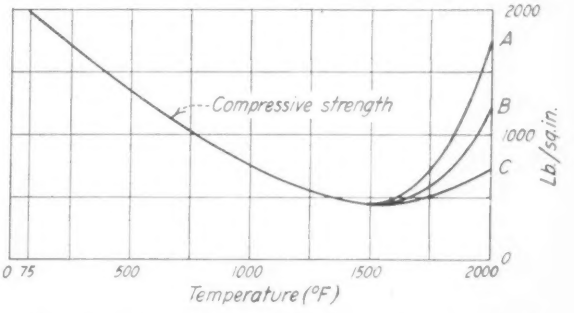

FIG. 3.—Curve below 1500°F is the standard design curve for these temperatures. Effect of addition of low vitrification clay on compressive strength of mixtures of cement and chrome at temperatures above 1500°F. *A* = 94 lb. low vitrification clay + 94 lb. cement in mix; *B* = 47 lb. low vitrification clay + 94 lb. cement in mix; *C* = 0 lb. low vitrification clay + 94 lb. cement in mix.

(3) Development of Fired Strength

The tests show that a fired strength is developed in concrete that is exposed to temperatures of 1500°F and higher, if a low vitrification clay is added to aggregates made from high vitrification clay and other aggregates, such as chrome, or if aggregates made from low vitrification clays are used (mixes A (2) and A (3) and Figs. 1, 3, and 5).

The addition of high vitrification clay to low vitrification aggregates seems to retard the fired strength (Fig. 4).

Mixes with aggregate made from high vitrification clays do not develop fired strength below 1750°F. A minimum low compressive strength of approximately 400 lb. per sq. in. can be assured only if clay is added to aggregates made from high vitrification clay (mixes M, N, O, P, and 4, Table V).

A comparison of mixes Nos. 1 and 2 (Fig. 4) shows that the addition of a high vitrification clay to aggregates made of a low vitrification clay retards the development of fired strength. The addition of low vitrification clay to aggregate made from high vitrification clay, however, tends to increase fired strength. The same is true when chrome ore is used as aggregate (Figs. 3 and 5).

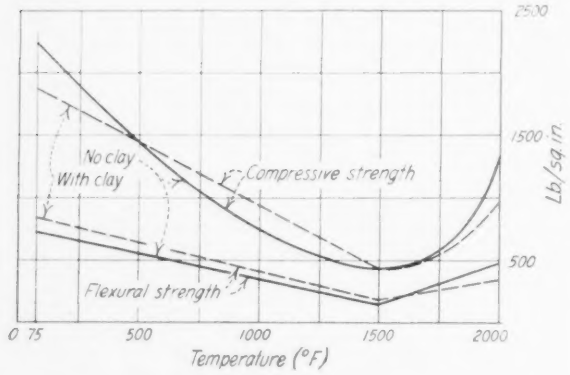

FIG. 4.—Effect on strength of adding high vitrification fire clay in the ratio of 25 lb. of clay to 94 lb. of cement with aggregate made from low vitrification clay.

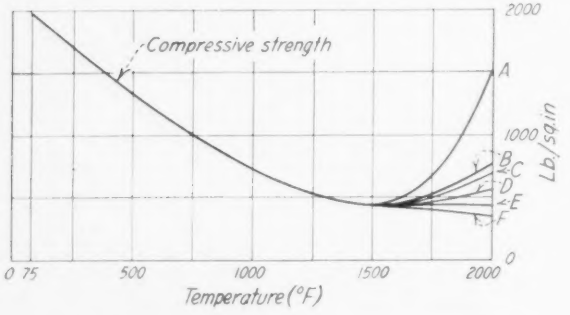

FIG. 5.—Effect of temperatures above 1500°F of fine material (passing 100-mesh sieve) on the compressive strength of mixtures of cement and high vitrification fireclay aggregate obtained by crushing old fire brick; the curve up to 1500°F is the standard design curve for these temperatures.

$A = 94$
$B = 70$
$C = 47$
} lb. low vitrification fire clay + 94 lb. cement.

D = 25 lb. high vitrification fire clay + 94 lb. cement.

E = 0 lb. clay (shown by one line on graph) { 20% aggregate passing 100-mesh sieve; 10% " " " " " "; 5% " " " " " "

F = 0 lb. clay { 0% " " " " " "

Mix: 1 bag cement and 4 cu. ft. aggregate.

The use of very dry mixes that require excessive ramming has some effect on the ultimate minimum strength of the concrete (see mixes N and Q). Experience with dry ramming mixes shows that the advantages offered are considerably outweighed by the difficulties in the field.

The use of a flux, such as borax or sodium carbonate, dissolved in water and applied after the concrete has hardened shows some advantage. The effect of the flux, however, is primarily on the surface and for a short distance in from the surface. The effect of the fluxes on larger units would be less than on smaller units. Additions of these fluxes to the fresh concrete interfere with the set and hardening of the cement.

A few of the test results are not consistent, and individual breaks in several tests have been given for these inconsistencies. It is significant that the highly inconsistent results are invariably higher than average. The fact

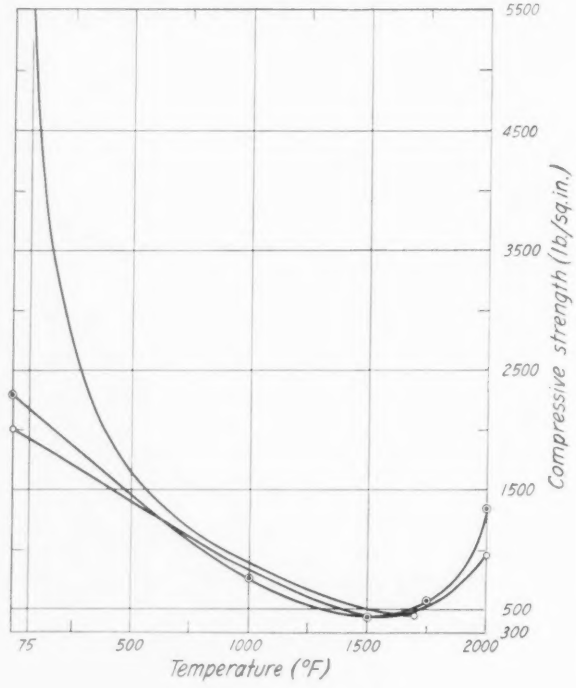

FIG. 6.—Relation of strength after heating to cold compressive strength of concrete exposed to high temperatures over long periods of time; calcium aluminate cement and various aggregates were used in the concrete.

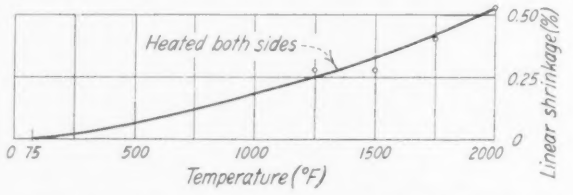

FIG. 7.—Linear shrinkage of refractory concrete; test made on 2- by 2- by 6-in. specimens; average of 36 specimens at 1250°F, 84 at 1500°F, and 45 at 2000° and 1750°F; mix: 1 bag of cement and 4 cu. ft. clay aggregate.

that so many specimens were placed in a furnace possibly may have prevented certain groups of specimens from reaching the specified temperatures. No other explanation occurs.

(4) Load Test While Hot

A block, 8 by 8 by 12 in., heated on one side at 1985°F for 4 hours and tested while hot, showed a compressive strength of 735 lb. per sq. in. Another block of the same size, heated on one side at 1550°F for 4 hours and tested while hot, showed a compressive strength of 833 lb. per sq. in.

These strengths check fairly closely the calculated strengths used in Fig. 1 as well as the formula in Fig. 8. The blocks were made from a mix of 1 bag of cement and 4 cu. ft. of Haydite.

(5) Linear Change

Nothing unusual is developed by the tests for linear change, which conform closely to results observed in the field. When the concrete is heated on all sides, there is a noticeable shrinkage which is offset to a considerable extent (not entirely) by the thermal expansion when the concrete is hot. When the concrete is heated only on one side, shrinkage is evident in one of two forms, viz., the hot surface develops (1) small hair cracks, sometimes invisible to the eye, which do not extend through the concrete, or (2) a few cracks which extend through the concrete. In each case, the thermal expansion of the materials while hot practically compensates for the shrinkage.

By comparing mixes M, N, O, and P with 0, 10, 15, and 20%, respectively, passing a 100-mesh sieve, no appreciable differences in shrinkage are noted.

The addition of raw clay shows some effect on the shrinkage. In using a high percentage of raw clay, one with the least amount of shrinkage should be selected (see mixes Nos. N, 4, X, and Y).

The quantity of water within reasonable limits used in the mix seems to have no effect on shrinkage (see mixes N and Q).

(6) Calculating Structural Strength in Furnace Walls of Refractory Concrete

The foregoing information will supply the data necessary to calculate the average strength of furnace walls, arches, or slabs. The temperature gradient should first be plotted for the wall thickness by using the temperature of the hot and cold faces. The thickness of the wall should be divided in sections of 1 or 2 in. With the average temperature for each section and the strength from the design curve for that temperature, the average strength for the concrete in the wall may be calculated. No structural strength should be calculated for that part of the wall in which the temperature exceeds 2250°F because the concrete in this area has a strength of less than 25 lb. per sq. in.

Example (1): A furnace wall, 6 in. thick, exposed to 2100°F on the hot face and 300°F on the cold face, gives a temperature drop of 1800°F or 600°F for each 2-in. section. The average temperatures (1) in the section containing the hot face are 1800°F, (2) in the middle section, 1200°F, and (3) in the section containing the cold section, 600°F. By referring to Fig. 1, the compressive strength (using the high vitrification aggregate) at 1800°F is 500 lb. per sq. in.; at 1200°F, it is 600 lb. per sq. in., and at 600°F it is 1200 lb. per sq. in. By adding 1200, 600, and 500 and dividing by 3 (the number of sections), the average compressive strength is 766 lb. per sq. in. for the concrete in the wall or 4596 lb. for each linear inch of wall.

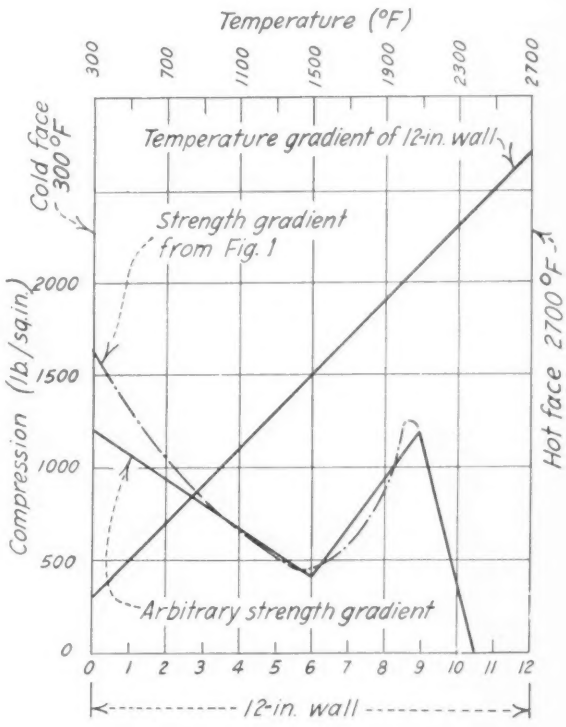

FIG. 8.—Wall strength of refractory concrete: *broken line*, strength gradient of refractory concrete wall 12 in. thick exposed to 2700°F on hot face, outside surface assumed to be 300°F; *solid line*, arbitrary straight-line strength. The following formula is taken from these curves: Effective structural strength in compression for each linear inch of wall is 800 times each inch of wall thickness exposed to a temperature of 2300°F and less.

Example (2): A 12-in. wall, exposed to 2700°F on the hot face with a cold face temperature of 300°F, gives a temperature drop of 2400°F or 400°F for each 2-in. section. The average temperature in the first 2-in. section is 2500°F, which has 0 lb. per sq. in. structural strength; section (2) has an average temperature of 2100°F and a structural strength of 600 lb. per sq. in.; section (3) has an average temperature of 1700°F and a structural strength of 450 lb. per sq. in.; section (4), a temperature of 1300°F and a structural strength of 500 lb. per sq. in.; section (5), a temperature of 900°F and a structural strength of 850 lb. per sq. in.; and the outside, section (6),

an average temperature of 500°F with a structural strength of 1350 lb. per sq. in. By adding 0, 600, 450, 500, 850, and 1350 and dividing by 6, the average compressive strength is 625 lb. per sq. in. for the 12-in. thickness, or 7500 lb. for each linear inch of wall (Fig. 8). This average strength should be modified by suitable factors which are explained in the following paragraphs.

The average strength obviously is not an exact measure of the effective strength of a wall whose elements have varying unit strengths. Formulas for exact strength may be integrated by means of calculus, but their application is laborious. Consideration should be given also to any difference in modulus of elasticity of the concrete at different temperatures. Assuming that these moduli do not differ appreciably, a simple approximation that will cover the most unfavorable conditions ordinarily encountered is feasible by assuming a wall whose unit strength increases uniformly from zero on the hot side to a maximum on the cool side. Considered as a column, its effective moment of inertia (and therefore its strength) is theoretically two thirds that of a wall in which an average strength is assumed to be uniformly distributed.

If the value found by the method of averages is reduced by one third, a strength is determined that is believed always to be on the safe side. This will represent the ultimate strength, to which a suitable factor of safety should be applied.

(7) Spalling

The spalling test, made by the dip method in this investigation, is not a satisfactory method to determine the resistance of refractory concrete to thermal spalling. The great difference in the results at 1000°F, when low vitrification clay aggregates (mix No. 1) were used, and at 1250°F, when high vitrification aggregates (mix No. 4) were used, is not borne out by field results.

The type of failure is entirely different from that observed on prefired brick. It is more in the nature of disintegration than spalling.

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THE CONCEPT OF "UNIT CLAY" AS AN AID TO GLAZE SLIP CONTROL*

By C. G. Harman

Consistency, as well as some other properties of glazes, is closely related to the properties and behavior of raw clay in the batch. It is simpler to study clay-water-electrolyte systems than the more complex glaze system, and information concerning the properties and reactions of clays may be applied directly to problems concerning glazes. Properties of clays may be judged from their base-exchange capacities and associated cations whether the clay is pure or is diluted with nonplastic constituents. Such a conception can simplify and clarify the problems of glaze consistency.

This is shown in Table I by a comparison of the quantities of different types of clays required to suspend a glaze.

Table I

Clay	Clay (%)	Exchange capacity (m.e./100 g. clay)	Exchange capacity (m.e./100 g. glaze)
Fla. clay	12	8	1
Vallendar	7	14	1
Laboratory sample	3	33	1
Bentonite	1.2	80	1

The degree to which different cations are adsorbed, *i.e.*, their tendency to flocculate or deflocculate clay, may be computed from their heats of hydration. It is sufficient for ordinary work, however, to regard all common cations (except the alkali ions) as causing flocculation if present in normal amounts. These considerations as well as the ordinary chemical reactions and the degree of solubility and ionization of their products clarify the behavior of electrolytes.

Spontaneous changes in electrolyte concentrations and their effects on the properties of suspensions are the chief reasons for the change of consistency with time. These changes may be minimized by the addition of appropriate stabilizing agents. Although these agents have been in use for a long time, it has not been possible until recently to predict which materials would be useful. Gieseking[1] states, "The large complex cations used in this investigation were very strongly adsorbed by montmorillonite. They were found to be exchanged by other cations of the same size but were not exchanged by hydrogen, which is very effective in replacing small cations . . . Montmorillonite, saturated with the large substituted ammonium ions, did not show the water adsorption, swelling, and dispersion characteristic of Ca-, Na-, and H-montmorillonite."

Protective action also results from the reactions of the ions with such complex materials as tannic acid to produce salts which are only slightly ionized. Many natural clays contain such large complex cations and acids which tend to stabilize slips made of them.

If a unit of clay were established with 1 milliequivalent base-exchange capacity per 100 grams and various physical and chemical properties correlated with this quantity, glaze control would be greatly simplified.

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* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 17, 1939 (General Session Symposium on Glaze Properties). Received April 17, 1939.

[1] J. E. Gieseking, "Mechanism of Cation Exchange in Montmorillonite-Beidellite-Nontronite Type of Clay Minerals," *Soil. Sci.*, **47**, 1–14 (1939); *Ceram. Abs.*, **18** [5] 136 (1939).

ACTIVITIES OF THE SOCIETY

THE PRESIDENT'S ADDRESS

DEVELOPMENTS IN CERAMICS*

By A. I. Andrews, *President, The American Ceramic Society*

Abstract

The developments in ceramics during the past decade have been extensive and, in many cases, spectacular. In every phase of the ceramic industry, progress has brought forth new and better processes. The improvement in control and the application of science and engineering have effected many changes. The industry is justly proud of the progress it has made and is looking forward to many more developments. This paper deals with the recent developments in the different branches of ceramics, pointing out the progress which has been made and the present trends.

I. Introduction

The use of ceramic products constitutes an important place in our modern civilization. To realize the truth of this statement, it is only necessary to reflect briefly on the many places where we have come to depend upon glass, enamels, refractories, whiteware, porcelain, structural clay products, abrasives, and cements. Not only has the individual become dependent on ceramic products, but practically all industry uses them in one way or another. Porcelain and glass are indispensable wherever electricity is used; refractories are necessary to metallurgical processes, power generation, and heating; enamels are important in the chemical industry, food industry, and brewing industry; clay products in architecture; abrasives in polishing and grinding; and cement in many forms of construction. The many applications would make a formidable list far too long to mention here. Ceramics has established itself as an important link in the progress of the world today.

Many of us have considered ceramics only in terms of our own particular branch of the industry, and we have failed to realize the progress that is being made in all the other phases. The word "ceramics" should be used more frequently because its meaning is not well understood by the public. It should be popularized through advertising, conversation, and correspondence. The ceramic industry, in all of its branches and as a whole, has made great progress in recent years.

The history of ceramics in most of its phases dates back to the activities of man when he first learned to build a fire and develop heat. The archeologist depends largely on the ceramic articles of pottery, glass, enamels, and brick to study the life and the progress of the beginnings of the development of our civilization. The history of ceramics offers an interesting story, for the increases in its scope are like the branches of a tree. The field is becoming so large that we find it difficult to keep ourselves informed of all of its developments.

II. Glass

The story of glass is an interesting one for it has intrigued man's curiosity for thousands of years. It is not my purpose, however, to review the history but to mention a few of the newer developments. This in itself makes spectacular reading because the development of glass cloth, shatterproof and invisible glass, and glass of many colors has often been a dream of the future which we have been fortunate enough to experience. Within only a few years, the drawing of fibers 0.00025 inch in diameter has grown from a laboratory experiment to a large industry. Few have realized the manifold uses for such a fiber. It is now being spun into thread and woven into cloth of good strength. This glass cloth is fireproof, verminproof, washable, and has properties similar to other fabrics. It is used for curtains, filter cloths, decorations, and as an insulation for the windings in electric motors. The fact that it withstands much higher temperatures than ordinary insulation permits the operation of motors at higher temperatures with a great increase in efficiency. This market alone is large. Glass wool or spun glass, which is a mass of fine fibers, is already a standard material used for heat insulation. Air conditioning in buildings is dependent on such materials.

Glass, in architecture, however, has gone even farther—the glass brick with its illumination, its heat insulation, and beauty has met with approval in many forms of construction. The day of the glass building is here and is no longer a dream of the future. Glass panels in colors are used extensively for store fronts and for decoration. Glass floor and wall tile, glass doors, and many forms of glass furniture, such as desks, table tops, and booths, are in common use. A lightweight aggregate faced with glass for unit construction has been introduced recently. Developments in the manufacture of window glass have so improved the product that the ordinary cheap run of glazing is better now than the select product of a few years ago. The introduction of shatterproof plate glass has given us greater

* Presented at the General Meeting, Golden Gate Exposition, San Francisco, Calif., August 7, 1939. Received August 14, 1939.

safety in our automobiles, trains, busses, and street cars. The quenched high-strength glass, four times stronger than ordinary plate glass, does not shatter; if it is broken, it tends to crumble, and if it flies at all, it does so in the plane of the glass sheet. This glass will withstand temperatures of 650°F and is used extensively for goggles, aquaria, and glazing, where high strength is desirable.

It is necessary only to mention the 200-inch mirror made by the Corning Glass Works for use in the telescope at Mt. Palomar in California, as most of you have read about it. There have been, however, many other recent developments in optical glass, such as the high index glass, the glasses of high-light transmission, the ultraviolet, polarizing, nonglare glasses, and the glass that transmits light and is opaque to X rays. The high index glass and the high-light transmission glass are important in optical instruments, and the nonglare glass, which is still in laboratory stage, offers great possibilities.

Nonglare glass is an ordinary glass coated with a thin transparent film exactly one quarter wave length of light in thickness. As light falls upon the glass, it is reflected both from the surface of the film and from the interface between the film and the glass. With a film exactly one quarter wave length thick, the light reflected from the interface is opposite in phase and equal in intensity to the light reflected at the surface of the film, resulting in an interference which prevents any light being reflected. There is, therefore, practically no light reflected from the surface of the glass and one cannot see it. Because the reflection from the surfaces of lenses causes 4 to 5% loss in light and because there are two surfaces, the loss owing to reflection is about 8% for each lens. This is important in a complicated optical instrument. Experiments show that with a single piece of glass treated in this manner, the transmission was increased from 92 to 99.2%.

Polarizing glass has met with many uses in optical instruments and offers wonderful possibilities in the future. It is a laminated safety glass, with literally billions of small oriented crystals suspended in every square inch of the cellulosic matrix between the two layers of plate glass. Light normally vibrates in all directions plane to the direction of propagation. Certain crystals and reflecting surfaces produce polarized light by eliminating all of the light which is not vibrating in one direction. Polaroid, because of the oriented crystals suspended in it, allows only polarized light to pass through it. If two sheets of such a glass are oriented so that they both polarize light in the same direction, light then passes through them. If, however, they are not oriented the same, only a slight amount of stray light can pass.

The applications of polarizing glass are many. It is already in use for photography, windows, goggles, display signs, ornaments, and strain testers. Inasmuch as reflected light is often polarized, goggles may be used to eliminate the glare from reflected surfaces. Polarized light may possibly be used some day for automobile headlights and windshields. The bright headlights of an approaching car in this manner would appear only dimly.

The use of glass-transmitting ultraviolet light has been somewhat overemphasized. Because only a small part of our body is actually exposed to sunlight and because sunlight contains only about 1% of ultraviolet light, the feasibility of using special glasses for transmitting this small amount of light is remote. Glasses especially opaque to ultraviolet light are used to protect valuable documents or other articles which are exposed for observation. A more important development in light transmission, however, is the glass which will transmit the whole range of the visible spectrum. These special glasses transmit 91% of the entire range, whereas ordinary glass transmits 89% with a rapid falling off toward both the red and the blue ends of the spectrum.

One-way vision glass has not yet been actually made. With certain glasses, it is possible to see from a darker to a lighter side and not from the light to the darker side. The heat transmission in special glasses has been greatly reduced, one having a 75% transmission of light and a 45% transmission of heat. The use of two panes of glass sealed into the same frame has been successful in accomplishing such a property. The air space between the two panes of glass serves as a good heat insulator and is used extensively on air-conditioned trains.

Many new articles and designs, such as the thin-walled nonreturnable bottles, pressed glass dinnerware, and glass cookingware to be used directly over a flame, have come on the market. One of the recent developments, not yet out of the laboratory, is a glass which has such a low coefficient of thermal expansion that it may be heated and then quenched in water.

Radical changes have also taken place in the manufacture of glass. Many plants have become obsolete in a relatively few years because of new developments in furnaces and machines. The increased efficiency of tanks has doubled the production per square foot of tank area. Batch handling has been improved and made automatic. The briquetting of the batch is being tried out. The introduction of feldspar in the ordinary soda-lime-silica glasses in amounts up to $1^1/_2$% has improved their durability and has resulted in much less attack on the glass furnace refractories. Automatic grinding of plate glass has become almost universal, and the machines for forming window glass, plate glass, and shapes such as bottles have not only been made more efficient, but they are simpler, and in many cases they are designed on entirely new principles. Electric lehrs and electric glassmelting furnaces have been meeting with considerable success.

III. Enamel

Enameling is the application of a thin layer of glass to a metal surface. It is involved, therefore, in all of the developments of the glass industry, and in many ways it is related to it. Like the glass industry, it is undergoing rapid growth. The one-time rule-of-thumb enameler is gone, and the practical engineer has taken his place.

The continuous furnace has replaced the older box-type furnace in large production sheet-steel and wet-process, cast-iron plants, and with it came the use of continuous conveyers, automatic equipment, and technical control of the operations. This change has been accompanied by the development of the electric and gas refrigerator and the stove and the washing-machine industries, which have grown so rapidly during recent years. Except for the outsides of refrigerators, such equipment is seldom finished with any material but porcelain enamel.

The introduction of enameling iron for architectural purposes dates back to 1895, but its advantages were not recognized until about 1933 at the Chicago World's Fair. Since that time, it has had rapid growth, and its use for gasoline service stations, store and building fronts, and lunch depots has become common. Other architectural uses are as wall tile, flue linings, interior panels, shower booths, and incinerators. It has proved popular and convenient in the modern type of architecture because of the unlimited range of color and design.

With the end of the prohibition era, a demand developed for glasslined storage tanks for beer. The enameler promptly met the need by developing designs suitable to the new industry, which started almost overnight. The method of support and the demand for lower costs were met. One company developed a process of atmospheric control for firing the enamels, which enabled them to enamel tanks in one piece as large as could be shipped by railroad. Many of these tanks are more than 40 feet long and 11 feet in diameter. They are fired by heating first to a red heat with atmospheric oxygen present, followed by a neutral atmosphere to complete the process.

A development which has meant a great deal to the enameler is the superopaque enamel. Before this type of glass was made, a thickness of 0.040 to 0.050 inch was necessary to get good coverage with white enamel. The superopaque enamel reduced this thickness to less than 0.030 inch, and it also reduced the tendency of the enamel to chip. This change resulted in better ware at a much lower cost. Fine milling of enamel has been introduced more recently, and, with the discovery of the use of sodium nitrite to prevent tearing, it is proving successful. The thickness of the enamel coating again was decreased, and enamelware is now manufactured with a thickness of as low as 0.010 inch, with better chipping resistance, good gloss, and less cost. This latest development has come so rapidly that its limitations are not yet known. It is no longer necessary to apply several coats of enamel with refiring each time to attain maximum quality. Much of our ware is produced with one ground-coat and one cover-coat application.

Improvements have been made in opacifiers, the tin oxide is better than ever before, and the introduction of improved zirconium opacifiers and other special opacifying compounds has met with considerable favor because of their lower cost. The color oxides and stains are more stable and dependable, and our methods of testing them are better.

The introduction of stabilizers to facilitate the production of a uniform white has been a great aid in the manufacture of one-coat ware. By the use of these stabilizers, defective ware may be recoated with approximately the same appearance on both the one-coat and two-coat ware so that the separate parts match.

The acid resistance of enamels is better understood, and the use of a dust spray of acid-resisting enamel over a superopaque first coat before firing has proved successful.

The use of the silk screen is being employed extensively for the decoration of enamelware, supplementing much of the brushing, printing, and decal which formerly were the only successful methods.

In dry-process enameling, sanitary-ware castings are now being made very thin to compete with sheet-steel ware, both of which have their advantages. The mechanical sandblast is being rapidly accepted to replace the more expensive air-blasting methods.

Special cleaners and wetting agents are being used to prepare the surface of the iron in the sheet-steel enameling process. The nickel dip has become more common, and special neutralizers such as cyanide are proving successful. Automatic cleaning and pickling machines and automatic blasting, spraying, and welding processes are being rapidly introduced. Enamel recovery and reclaim have received much attention recently.

Enamels are being fired at lower temperatures, which has reduced costs, has eliminated warping and sagging of the iron, and has made possible one-piece refrigerator shells, stoves, and many other articles, which formerly were assembled after enameling.

The education of the designer and enameler in developing good enamelware design, the use of electric butt and stitch welding, and the improvement in the drawing qualities of the steel have aided advancement. The drawing of steel has progressed to such a point that washing-machine tubs are now drawn from a flat sheet in one operation.

The use of the radiant tube in place of the refractory muffle has improved the condition in gas-fired furnaces and has eliminated much of the trouble with flue gases affecting the ware. Special tests have been developed to determine reflectance and color and acid, abrasion, and impact resistance. The continuous smelter is making possible more uniform frits with a maximum efficiency.

IV. Refractories

The refractories industry involves not only the manufacture of brick, but, with the industries it services, it has developed and expanded to meet new demands and to serve old ones better. Engineers are employed as sales and service men, and the industry sells both product and service. Better refractories are now and always will be in demand. Because refractories often limit the temperatures and conditions which can be used in a certain process, an improved refractory product leads to more severe conditions and a demand for something even better. "Something better" is being produced, but the refractories engineer, in collaboration with the user, is also constantly studying the furnace construction and operation to improve the life of refractories.

The plastic refractory has introduced an entirely new method of installing refractories. The development of plastic refractories, refractory cements, mortars, and lutes has brought forth many changes in furnace design and practice. The boiler furnace no longer uses the great quantities of brick that it did at one time.

In the development of plastic refractories, studies of grain size and distribution to control the properties of the product have been important contributions. Chemical bonds and colloidal bonds, as well as gums and inorganic cements, have added greatly to the knowledge of controlling the properties of refractories. The low-porosity, high spalling-resistant refractories are a result of such studies of grain, bond, and processing.

Phase studies of the relation of the minerals in refractories to their properties have made important strides.

The mineral constitution as well as the structure is determined by the use of the petrographic microscope and X ray.

The heat-insulating refractory has been a great aid to the furnace engineer. By the use of these high-temperature, heat-insulating refractories, a furnace is brought up to temperature in less time, and great heat losses through the walls and roof are prevented. A careful study is being made of the use of these insulating refractories, which are now being installed in many places, such as glass tanks and open-hearth roofs, where their use formerly had not been anticipated. The refractories producer works in close coöperation with the furnace engineer, quite contrary to the old order of events when he only made brick and said "come and get them."

Insulating refractories are made from kaolin or other refractory materials in which a microscopic bleb formation is developed by vaporizing an organic compound, by a chemical reaction, or by combustion of organic materials finely divided in the brick. These tiny blebs act to reduce the bulk weight of the brick and act as insulation to the flow of heat.

An insulating refractory with lower temperature limits which is in use is the expanded mica (vermiculite). It has proved to be a lower priced but efficient insulator, and it is used to back up furnace walls or for driers.

The use of forsterite and olivine refractories, the manufacture and marketing of unfired magnesite and chrome brick, the cast mullite blocks, and the bonded sillimanite blocks are other important developments.

The discovery of the use of diaspore has led to a whole series of diaspore-containing refractories which have proved superior for many purposes. Zircon refractories are now used for high-heat duty, and improvements have been made in silicon carbide refractories.

The development of the calcium aluminate cement as a bond for cast refractory concretes has met with considerable success in many places. Its use is similar to that of Portland cement, except that a refractory aggregate is employed and it will withstand furnace temperatures. It is sometimes used as a bond in refractory cements.

The use of the tunnel kiln has done much to attain uniformity of refractories products. It is now possible to fire even silica brick in a tunnel kiln. Forming methods have been improved and utilized to control the structure and properties of refractories. Silica brick are now being dry-pressed, whereas in the past they were all made by hand or the drop method. Glass tank blocks which required expensive labor to form are now being cast in slip form. The use of wetting agents, special electrolytes, and new methods for the preparation of the slip have made this possible.

Deairing machines have improved the forming process of refractories and they are becoming standard equipment. The re-press and the power press after extrusion insures better and more uniform refractories.

The slag test has led to great improvement in the slag resistance of refractories. Extensive studies of the physical properties and the coöperative correlation of service data are constantly adding to the knowledge of refractories production.

V. Structural Clay Products

In the structural clay products field, many new and special shapes have been introduced to meet the modern demands of the architect and the competition from other materials. Reinforced masonry has permitted brick construction for floors, platforms, bridges, and in other places where increased strength is necessary. Many special tints have been developed by flashing with zinc and by the increased knowledge of the control of the kilns during this part of the firing process.

The introduction of clay with Portland cement to prepare a new product called "mortar mix" is coming into use in some parts of the country. The clay increases the working property of the mortar, and the product has been reported to be superior to lime, which has been in extensive use for many years.

Roofing granules are now being made in many parts of the country. Shale or a similar material is ground, sized, and fired in rotary furnaces. The product is again sized, glazed, and refired in a vertical, multiple-hearth furnace to produce colored granules. The development of the colors has required extensive research, which has yielded a satisfactory product. These granules are used on bituminous roofing paper and shingles.

Lightweight aggregates, made by firing shale rapidly which causes it to bloat like a cinder, are used for lightweight concrete construction. A rotary kiln is used in this process, and the shale is heated so rapidly that the organic matter in the shale does not have a chance to oxidize and escape before it is trapped. This causes severe bloating because of the entrapped gases. Some of the plants have expanded production to include certain special ware, such as floor and wall tile and specially designed silo blocks, as well as the drain tile and sewer pipe.

In the manufacture of structural clay products, deairing equipment has made possible the use of the stiff-mud process for many shapes which formerly could not be made by this method; it has also made possible the manufacture of more intricate shapes. In the chemical stoneware industry, for example, long tubes are made by this process and are wound into coils in the plastic condition. Machine-made terra cotta is also a reality after many years of effort.

The facing of common brick in districts which do not yield good face-brick clay has brought to such parts of the country much better looking brick without the necessity of shipping great distances.

The development of better driers, based on an extensive study of the drying behavior of clays; improvements in firing, based on similar studies of the firing process; and the introduction of the tunnel kiln in some plants have brought greater efficiency. Production has also been "stepped-up." In one plant, for example, 365,000 brick are produced on one double end-cut, stiff-mud machine in eight hours, with an average production of 300,000.

Sewer pipe are being made as large as 36 inches in diameter, and deairing is used in the preparation of the plastic clay.

VI. Whiteware

Outstanding in the whiteware industry are the improvements in design, color, and decoration of pottery and dinnerware. These developments have contributed consid-

erably to the popular acceptance of American ware in preference to the foreign product. The unsettled foreign situation is also aiding the domestic potter, because the low-cost labor abroad has always been a handicap to our home industry.

The industry, however, is also overcoming its disadvantages by the introduction of modern labor-saving equipment. Deairing, employed to improve the ware, is also yielding a more uniform and better working body. The tunnel kiln, continuous conveyers, improved conveyer driers, automatic jiggers, spraying and dipping machines, and the technical control of the slips and the various operations are doing much to improve production. Dry mixing of bodies to improve the blending of the different constituents, special dewatering methods, such as spraying in a hot dry room, and automatic pressing are rapidly entering the industry. The life of saggers has been lengthened; and, in some cases, saggers are cast instead of being made by the old press method. Kiln furniture in general has been greatly improved.

New and better bodies have been developed. In the electrical-porcelain field, an extensive study has been made of the properties and the effect of composition and processing. We are all familiar with the improvement in spark plugs. The old type of clay-feldspar-flint body was not suitable because the flint caused low heat-shock resistance and the feldspar caused electrical leakage. Spark-plug bodies now are either of the mullite or the zircon type. Insulators and porcelain in general have met with similar improvement.

The use of magnesia minerals in porcelain bodies has led to outstanding types. One body is essentially a composition containing cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$) and is compounded from talc, clay, and alumina; it has a low thermal expansion, extremely low porosity, high strength, low dielectric loss, and a great resistance to thermal shock. Although the firing range is short, these cordierite bodies have found important use in radio equipment. They may be fired to a glazed surface by adding small amounts of feldspar, and if zirconia is added, they have a fairly long firing range.

The steatite bodies, in which the primary crystal is clinoenstatite ($MgO \cdot SiO_2$), have greater strength, are finer grained than the cordierite bodies, and the electrical properties are satisfactory for high-frequency electrical work. These bodies are being used extensively.

High-dielectric constant bodies are made from TiO_2 or ZrO_2, sometimes being essentially a one-phase system. Special conditions are encountered in the chemical industry, and mullite, silicon carbide, zircon, corundum, or magnesia may be found in these bodies. Nonplastic materials are difficult to work and form, but the use of mullite, silicon carbide, and zircon in heat-resistant bodies has given much improvement.

Experiments and studies of clays have led to better casting slips, and much of the ware is cast even if later it is to be jiggered. Many good colored bodies have been developed, and glazes have been improved to lessen the crazing tendency. Decoration by the screen process, spraying through stencils, and other methods have given much more flexibility to design.

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VII. Other Fields

Other fields of ceramics, such as abrasives and Portland cement, have made great strides. In the abrasive industry, studies of grain size and distribution, the different kinds of grain and their development, the silicate and the organic bonds, and the methods of forming the ware have been improved. Precision in the making of grinding equipment to size and shape has been an important development. New materials, such as tungsten carbide, boron nitride, and many others, have been perfected. The quality of powdered abrasives, the control of the grain size, and the uniformity of the product is another illustration of the progress in this industry.

In the Portland cement industry, many mechanical changes have been made during recent years, but the general process has been unchanged. Fine grinding of the clinker has yielded better early strength cements; and the improved control of the batch to prevent segregation has led to a more uniform product. Air separation is being introduced or used in many clinker grinding plants.

The mineral constitution of Portland cement has been studied extensively. The identity, function, and characteristics of each of these minerals are known. The cement producer no longer judges his product only by routine standard tests; he is also interested in some of the less obvious characteristics. Standards for heat evolution during setting have developed in the government specifications for cements to be used for large structures such as dams. The substitution of iron for alumina in the cement avoids the formation of 3CA, which develops most of the heat, and in its place a compound, 4CAF, is formed, which has a much lower heat of setting. The principal compounds in Portland cements, however, are 2CS, which sets very slowly, and 3CS, for early strength. The control of the constitution of cements and the use of retarders and accelerators make it possible to control many of the properties of Portland cements.

The new high aluminous cement, used extensively for refractory cement, has required new methods of burning. A rotary kiln is used, but it is carried beyond the clinkering stage to complete fusion. The molten product is cast in pigs and then crushed and ground for the market. It consists essentially of C_3A_5 and CA, which have excellent rapid hardening properties, and smaller amounts of C_2S, which sets slowly. This type of cement is resistant to salt water and may be used for service at high temperatures.

VIII. Raw Materials

It is not possible to discuss all of the new raw materials which have been introduced to the ceramic market. As a supplement or substitute for feldspar, many minerals are being promoted. Each of these shows special advantages and bids well for the market. Nepheline syenite is a mineral of the sodium-aluminum-silicate type, but it differs from feldspar in that it has only two silica molecules instead of the customary six in a feldspar. Its high flux and alumina content make it attractive to the glass industry, and it has found important use in bodies.

Aplite has a similar composition, but it is composed of soda and potash feldspars, zorsite, and sericite mica. It is new to the industry, but it appears to have an important application in glass.

Pyrophyllite is a hydrous aluminum silicate ($Al_2O_3 \cdot 4SiO_2 \cdot H_2O$) which has attracted considerable attention for use in ceramic bodies, certain enamels, and as a refractory.

Uses for kyanite, andalusite, and sillimanite are familiar to most ceramists. Dehydrated borax has proved to be of advantage over the hydrated article in enamels. Its shipping costs are only about one half that of ordinary borax, and there is a great saving in the consumption of heat during smelting. Larger frit batches may be used in a given size smelter. Bentonites and lithium minerals, such as spodumene, amblygonite, and others, are showing advantages in ceramic products. The alginates, wetting agents, organic binders, colloidal binders, electrolytes, and many other types of materials, a list too long to mention here, are also finding their places in ceramic production.

Department of Ceramic Engineering
University of Illinois
Urbana, Illinois

FORTY-SECOND ANNUAL MEETING, AMERICAN CERAMIC SOCIETY

The Forty-Second Annual Meeting of The American Ceramic Society will be held at the Royal York Hotel in Toronto, Canada, the week of April 7, 1940.

The President of the Canadian Ceramic Society has already appointed the following Local Committee to assist with arrangements for the Meeting:

Honorary Chairmen: A. U. Coté, Dean C. H. Mitchell, Ryland H. New, and Wilfred Mavor.

Chairman: William McGolpin, National Fire Proofing Co., Ltd., Toronto.

Secretary: Gordon C. Keith, 49 Turner Rd., Toronto, 10, Canada.

General Committee: H. A. Bevens, H. F. Dingledine, W. F. Findlay, George Hunt, G. C. Irvine, W. A. Irvine, R. J. Montgomery, W. E. Patterson, W. P. Pulkingham, B. Stone, and Theo. Tafel, Jr.

SAN FRANCISCO GENERAL MEETING

Members of The American Ceramic Society who attended the General Meeting, August 6 to 12, have been sending enthusiastic reports not only of the social events but of the technical sessions as well.

The average attendance at the technical sessions ranged from forty to sixty persons, and 160 attended the banquet held on Monday evening, August 7. The papers scheduled for this program are being received and will be published in coming issues of *The Bulletin*.

A. I. Andrews, President of The American Ceramic Society, received complimentary notices from San Francisco papers on his address entitled "Developments in Ceramics." This paper is published in this issue of *The Bulletin*, pp. 333–38.

Our West Coast members are to be congratulated on their efficient organization for this Meeting.

MEETING REGISTRATION FEES*

Here Is the One and Only Protest Received

"In response to your letter of June 23, I find that I am not in complete sympathy with the procedure which has been followed on Meeting Registration Fees and cannot endorse the statement which has been prepared as a means to justify this procedure to the membership.

"The practice of charging members the same high fee as visitors puts an unequal burden on the members who make the Meetings possible. Some members may not attend rather than pay $5.00 to enjoy their own Meeting, whereas some people do not join The Society because they are interested mainly in the Meeting and the dues and fees together are too much. The only reasonable procedure would be to charge members $2.00 or possibly $3.00 and to charge visitors $5.00.

"The practice of paying for the entertainment out of the registration fee is particularly irking and is as unjust to the members who do not attend the entertainment as the practice of paying for the Meeting out of the general funds would be to those who do not attend the Meeting. The only equitable solution is to make a separate charge for attendance at the entertainment or to abandon it altogether. From the appearance of the amounts spent on each in the past, there appears to be some confusion as to whether the Meeting is held for ceramic or social reasons.

"If the statement were prepared so as to promote an expression from the membership at large, I would gladly endorse it."

* See the August *Bulletin*, p. 298.

ART DIVISION MEETING, BLUE RIDGE, N. C.

The Art Division of The American Ceramic Society held a two-day meeting at Blue Ridge, N. C., August 17 and 18, in conjunction with the Fifth Annual Coöperative Art Conference.

Nearly fifty persons attended each meeting. These included members of The Society from different parts of the country as well as art teachers and artists who are keenly interested in ceramic art. There were twelve states represented outside of North Carolina from as far distant as California, Maine, and Louisiana. It was an enthusiastic gathering, with everyone taking part in the discussions.

Five papers were read pertaining to ceramic art. There were demonstrations of throwing on the wheel, modeling, mold-making, casting, and firing. Pottery exhibits were loaned by the NYA ceramic project of Georgia, Georgia Art Pottery, Pisgah Forest Pottery, Hilton Pottery, Ohio State University, and Newcomb College. Several pieces were sold from these exhibitions.

Two moving pictures of pottery making were shown in Lee Hall on Thursday night to a group of more than one hundred persons. On Friday afternoon, a trip was made by the group to the Pisgah Forest Pottery. A radio talk on ceramic art was given on Friday afternoon by Kenneth E. Smith of Newcomb College, over station WWNC at Asheville, N. C.

There is a desire on the part of the Blue Ridge Art Conference to continue these summer meetings. W. B. Weatherford, president of the Blue Ridge College, Inc., and R. M. Grumman, head of the extension department of the University of North Carolina, appreciate this activity on the part of The American Ceramic Society.

—Kenneth E. Smith

CORRECTION ON SILVERMAN MOTION-PICTURE FILMS

The August *Bulletin*, page 310, contains an announcement listing the motion-picture films presented to The American Ceramic Society by Alexander Silverman. A correction should be made on the information in the August notice.

Dr. Silverman writes, "It is true that I presented the 1600 feet on the ceramic tour, but I did not present the films showing my glass collection. I still have them. My second gift was a short reel of pictures taken at the fall meeting of the Glass Division in Cambridge Springs several years ago. Please correct the announcement, as the films of my glass collection *are not available for public use.*"

THE INSTITUTE OF CERAMIC ENGINEERS

Executive Committee

President: J. L. CARRUTHERS, Ohio State Univ., Columbus, Ohio.

Vice-President: H. G. WOLFRAM, Porcelain Enamel & Mfg. Co., Baltimore, Md.

Secretary: S. J. McDOWELL, General Ceramics Co., Keasbey, N. J.

Past-President: A. F. GREAVES-WALKER, Univ. of North Carolina, Raleigh, N. C.

Trustee Representative: R. E. BIRCH, Harbison-Walker Refractories Co., Pittsburgh, Pa.

D. C. Licensing Bill

The value of the Institute to the ceramic engineers and the type of service it is rendering them is demonstrated in the results of the efforts of the Executive Committee to have ceramic engineers included in the engineers' licensing bill which was before the last session of Congress.

The bill, S1128, as originally written, did not include ceramic engineers, and if it had been passed in its original form, they could not have been licensed to practice professionally in the District of Columbia. The bill was brought to the attention of the Executive Committee of the Institute by the American Engineering Council.

Upon being advised of the situation, the members of the committee immediately got into communication with senators and representatives from states, such as Ohio and Pennsylvania, in which the ceramic industries are strongly represented, requesting their assistance in having the ceramic engineers included. As a result of these efforts the House subcommittee of the District of Columbia included ceramic engineers in the bill.

The bill was acted on favorably by the Senate. The bill reached the House during the last hectic days and as there developed a slight opposition to some provisions of the bill, it was referred back to the District Committee and will have to await the next session for further House action. The Executive Committee is advised by the American Engineering Council that there is little doubt that it will be passed at that time.

The Executive Committee realized that few ceramic engineers would take advantage of the act to obtain professional licenses in the District of Columbia. It appeared to be extremely important, however, that they be included because of the influence such inclusion by Congress would have on State Boards of Examiners that have not as yet recognized ceramic engineering.

The committee was greatly aided in its efforts by Secretary Feiker of the American Engineering Council who kept it advised by telegraph and letters regarding the dates of hearings and the action of House and Senate committees considering the bill.

New Institute Members

Member Grade

R. H. Schwendler, Eddy Road & Taft Ave., Cleveland, Ohio

W. A. Koehler, Mechanical Hall, Morgantown, W. Va.

Associate Member Grade

A. L. Bennett, 2901 Los Feliz Blvd., Los Angeles, Calif.
J. L. Austin, Buffalo Ave., Niagara Falls, N. Y.
F. W. Schroeder, A. P. Green Fire Brick Co., Mexico, Mo.
W. R. Kerr, Armstrong Cork Co., Beaver Falls, Pa.
S. S. Cole, National Lead Co., South Amboy, N. J.
H. G. Baldauf, National Tile Co., Anderson, Ind.
L. A. Trabert, Joaquin Potteries, Stockton, Calif.
J. E. Rankin, Pine Hall, N. C.
J. T. Sellers, Morrow Mfg. Co., Wellston, Ohio

NEW MEMBERS JOIN IN AUGUST

Corporation

AMERICAN MINERALS CO., Joseph A. Stanko (voter), 2808 S. Pacific St., San Pedro, Calif.

Personal

ATKINS, KENNETH D., 312 North York, Martinsville, Ill.

BAUER, WOLF G., Roche Harbor, Wash.; chemical engineer, Roche Harbor Lime & Cement Co.

CHIN, Y. L., 88, East of Niang-Niang-Kung, Tientsin, China; director, Teh Sheng Ceramic Factory.

COEN, BERNARD, Y.M.C.A., Kokomo, Ind.; ceramic engineer, Kokomo Sanitary Pottery Corp.

COLEMAN, ROBERT L., 8010 Calumet, Chicago, Ill.; laboratory assistant, Illinois Brick Co.

FICHTER, GEORGE W., 2206 Duncan Ave., Chattanooga, Tenn.; American Lava Corp.

KIRKENDALE, GEORGE A., Dept. of Mines, Industrial Minerals Div., Lydia St., Ottawa, Ontario, Canada; ceramic engineer.

LIEDER, PHILLIP H., 108 Montgomery Ave., R.F.D. 3, Norristown, Pa.; junior ceramic engineer, E. J. Lavino & Co.

LUEDERS, ROLAND, Federal Seaboard Terra Cotta Corp., South Amboy, N. J.; ceramic engineer.

MANSUR, HOWARD H., Gladding, McBean, & Co., Lincoln, Calif.; assistant superintendent.

MIDDLETON, GEORGE J., Gladding, McBean, & Co, Lincoln, Calif.; ceramist.

POLIVKA, JAR., 2815 34th St., Astoria, Long Island, N. Y.; consulting engineer.

SANDERS, HERBERT H., San José State College, San José, Calif.; assistant professor of art.

*SCHREIBER, ARMIN L., 2300 E. 52nd St., Los Angeles, Calif.; general superintendent, Vernon Kilns.

SHIPLEY, McLINDEN E., Messrs. Mobberley & Perry, Ltd., Stourbridge, Worcestershire, England; chief chemist.

TALBOTT, PAUL T., Cerro de Pasco Copper Corp., La Oroya, Peru, South America; assistant foreman.

UHRMANN, CARL J., P.O. Box 13, Bellaire, Ohio; vice-president, Imperial Glass Corp.

*VANCE, EDWARD D., Bay State Abrasive Products of Canada, Ltd., Brantford, Ontario, Canada.

WILLIAMS, JOSEPH S., P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.; chief engineer.

Student

University of Illinois: WILLIAM C. BROWNING.
University of North Carolina: JOSEPH C. RICHMOND.
Ohio State University: JAMES K. STEVENSON, JR.
Pennsylvania State College: GEORGE H. ANTHONY.
Rutgers University: GLENN HOWATT and GIRARD W. PHELPS.

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MEMBERSHIP WORKERS' RECORD

Corporation

	E. L. Maxson		1

Personal

H. E. Davis	1	E. H. Spencer	1
J. T. Ogden	2	J. G. Stewart	1
J. G. Phillips	1	Hans Thurnauer	1
Colin Presswood	1	Office	10
Kenneth E. Smith	1		

Student

A. I. Andrews	1	Office	4
A. C. Francisco	1		
		Grand Total	**26**

* Indicates former member of The Society rejoining.

ROSTER OF CORPORATION MEMBERS

Abbé Engineering Co., New York, N. Y.
Abingdon Sanitary Mfg. Co., Abingdon, Ill.
A C Spark Plug Co., Flint, Mich.
Akron Porcelain Co., Akron, Ohio
American Gas Assn., New York, N. Y.
American Lava Corp., Chattanooga, Tenn.
American Nepheline Corp., Rochester, N. Y.
American Potash & Chemical Corp., New York, N. Y.
American Refractories Institute, Pittsburgh, Pa.
American Rolling Mill Co., Middletown, Ohio
American Stove Company, St. Louis, Mo.
Amsler-Morton Co., Pittsburgh, Pa.
Anchor Hocking Glass Corp., Lancaster, Ohio
Arketex Ceramic Corp., Brazil, Ind.
Atlantic Terra Cotta Co., Perth Amboy, N. J.

Babcock & Wilcox Co., New York, N. Y.
Ball Brothers Co., Muncie, Ind.
Baltimore Enamel & Novelty Co., Baltimore, Md.
Bausch & Lomb Optical Co., Rochester, N. Y.
Binghamton Brick Co., Inc., Binghamton, N. Y.
Blue Ridge Glass Corp., Kingsport, Tenn.
Blythe Colour Works, Ltd., Cresswell, Stoke-on-Trent, England
Bonnot Company, Canton, Ohio
Braun Corp., Los Angeles, Calif.
Brockway Glass Company, Inc., Brockway, Pa.
Buck Glass Company, Baltimore, Md.
Buffalo Pottery, Buffalo, N. Y.

Canadian General Electric Co., Ltd., Peterborough, Ontario, Canada
Canton Stamping & Enameling Co., Canton, Ohio
Carborundum Company, Niagara Falls, N. Y.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Carr-Lowrey Glass Co., Baltimore, Md.
Celo Mines, Inc., Burnsville, N. C.
Central Silica Company, Zanesville, Ohio
Ceramic Color & Chemical Mfg. Co., New Brighton, Pa.
Certain-Teed Products Corp., Buffalo, N. Y.
Champion Spark Plug Co., Detroit, Mich.
Chattanooga Glass Co., Chattanooga, Tenn.
Chicago Hardware Foundry Co., North Chicago, Ill.
Chicago Pottery Co., Chicago, Ill.
Chicago Vitreous Enamel Product Co., Cicero, Ill.
Clark, N., & Sons, San Francisco, Calif.
Commercial Decal Products, Inc., East Liverpool, Ohio
Coors Porcelain Company, Golden, Colo.
Corhart Refractories Co., Inc., Louisville, Ky.
Corning Glass Works, Corning, N. Y.
Crane Enamelware Company, Chattanooga, Tenn.
Cronin China Co., Minerva, Ohio
Crooksville China Co., Crooksville, Ohio
Crossley Machine Co., Trenton, N. J.
Crossman Company, South Amboy, N. J.
Crown Potteries Co., Evansville, Ind.

DeVilbiss Co., Toledo, Ohio
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Drakenfeld, B. F., & Co., New York, N. Y.
Du Pont de Nemours, E. I., & Co., R. & H. Chemicals Dept., Wilmington, Del.

Edgar Plastic Kaolin Co., Metuchen, N. J.
Electro Refractories & Alloys Corp., Buffalo, N. Y.
Engelhard, Charles, Inc., Newark, N. J.
Engineering & Construction Div., Koppers Company, Pittsburgh, Pa.
English China Clays Sales Corp., New York, N. Y.
Eureka Flint & Spar Co., Trenton, N. J.
Exolon Company, Blasdell, N. Y.

Fairfacts Company, Inc., Trenton, N. J.
Federal Seaboard Terra Cotta Corp., Perth Amboy, N. J.
Ferro Enamel Corp., Cleveland, Ohio
Findlay Clay Products Co., Washington, Pa.
Fords Porcelain Works, Perth Amboy, N. J.
Fostoria Glass Co., Moundsville, W. Va.
Frazier-Simplex, Inc., Washington, Pa.

Garco Products, Inc., Butler, Pa.
General Ceramics Co., New York, N. Y.
George, W. S., Pottery Co., East Palestine, Ohio
"Giesche" Fabryka Porcelany Sp. Akc., Katowice-Bogucice, Poland
Gillinder Brothers, Inc., Port Jervis, N. Y.
Gladding, McBean, & Co., Lincoln, Placer County, Calif.
Gleason-Tiebout Glass Co., Maspeth, N. Y.
Glenwood Range Co., Taunton, Mass.
Great Lakes Foundry Sand Co., Detroit, Mich.
Great Lakes Steel Corp., Detroit, Mich.
Green, A. P., Fire Brick Co., Mexico, Mo.

Haeger Potteries, Inc., Dundee, Ill.
Hall China Company, East Liverpool, Ohio
Hancock Brick & Tile Co., Findlay, Ohio
Hanley Company, Summerville, Pa.
Hanovia Chemical & Mfg. Co., Newark, N. J.
Hardinge Company, Inc., York, Pa.
Harshaw Chemical Co., Cleveland, Ohio
Hartford-Empire Co., Hartford, Conn.
Haws Refractories Company, Johnstown, Pa.
Hazel-Atlas Glass Co., Wheeling, W. Va.
Hommel, O., Co., Pittsburgh, Pa.
Houze, L. J., Convex Glass Co., Point Marion, Pa.
Hygrade Sylvania Corp., Emporium, Pa.

Idaho Fire Brick & Clay Co., Troy, Idaho
Illinois Clay Products Co., Joliet, Ill.
Ingram-Richardson Mfg. Company of Indiana, Inc., Frankfort, Ind.
International Smelting & Refining Co., Akron, Ohio
Irish Glass Bottle Co., Ltd., Dublin, Ireland
Isolantite, Incorporated, Belleville, N. J.

Jova Brick Works, Roseton, N. Y.

Kaolin, Incorporated, Spruce Pine, N. C.
Kentucky Clay Mining Co., Mayfield, Ky.
Kentucky-Tennessee Clay Co., Mayfield, Ky.
Knowles, Edwin M., China Co., Newell, W. Va.
Kohler Company, Kohler, Wis.
Kraftile Company, Niles, Calif.

Laclede-Christy Clay Products Co., St. Louis, Mo.
Lancaster Iron Works, Lancaster, Pa.
Lapp Insulator Co., Inc., Le Roy, N. Y.
Laughlin, Homer, China Co., Newell, W. Va.
Lava Crucible Co. of Pittsburgh, Pittsburgh, Pa.
Lee Clay Products Company, Clearfield, Ky.
Libbey Glass Company, Toledo, Ohio
Libbey-Owens-Ford Glass Co., Toledo, Ohio
Limoges China Co., Sebring, Ohio
Lindemann, A. J., & Hoverson Co., Milwaukee, Wis.
Locke Insulator Corp., Baltimore, Md.
London Brick Co., Ltd., London, England
Louthan Manufacturing Co., East Liverpool, Ohio
Lynch Corporation, Anderson, Ind.
Lynch, A. J., & Co., Los Angeles, Calif.

Maryland Glass Corp., Baltimore, Md.
Mason City Brick & Tile Co., Mason City, Iowa
Maxson, Elwyn L., Los Angeles, Calif.
McHose, L. H., Inc., Perth Amboy, N. J.
McKee, Arthur G., & Co., Cleveland, Ohio
Metal & Thermit Corp., New York, N. Y.
Metro Glass Bottle Co., Jersey City, N. J.

Mississippi Glass Co., New York, N. Y.
Mitchell Clay Mfg. Co., St. Louis, Mo.
Moore Enameling & Mfg. Co., West Lafayette, Ohio
Moore & Munger, New York, N. Y.
Mosaic Tile Company, Zanesville, Ohio
Mount Clemens Pottery Co., Mount Clemens, Mich.

National Engineering Co., Chicago, Ill.
National Fireproofing Corp., Pittsburgh, Pa.
National Gypsum Co., Buffalo, N. Y.
National Industrial Sand Assn., Washington, D. C.
National Lead Co., Brooklyn, N. Y.
National Lime and Stone Co., Findlay, Ohio
Newbold Silica Fire-Brick Co., Ltd., Sydney, N.S.W., Australia
New Castle Refractories Co., New Castle, Pa.
New Jersey Porcelain Co., Trenton, N. J.
New Jersey Pulverizing Co., New York, N. Y.
Nippon Gaishi Kabushiki Kaisha, Nagoya, Japan
Nippon Toki Kaisha, Ltd., Nagoya, Japan
North American Refractories Co., Cleveland, Ohio
North Carolina Feldspar Corp., Erwin, Tenn
Norton Company, Worcester, Mass.

Ohio Insulator Company Div., Ohio Brass Co., Barberton, Ohio
Old Hickory Clay Co., Paducah, Ky.
Olean Tile Co., Olean, N. Y.
Onondaga Pottery Co., Syracuse, N. Y.
Orton, Edward, Jr., Ceramic Foundation, Columbus, Ohio
Owens-Illinois Glass Co., Alton, Ill.
Owens-Illinois Pacific Coast Co., San Francisco, Calif.

Pacific Clay Products, Los Angeles, Calif.
Pacific Tile & Porcelain Co., Los Angeles, Calif.
Paper Makers Importing Co., Inc., Easton, Pa.
Pass & Seymour, Inc., Solvay, N. Y.
Pennsylvania Pulverizing Co., Lewistown, Pa.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.
Pfaudler Company, Rochester, N. Y.
Pittsburgh Plate Glass Co., Creighton, Pa.
Porcelain Enamel & Mfg. Co., Baltimore, Md.
Portsmouth Clay Products Co., Portsmouth, Ohio
Potters Supply Co., East Liverpool, Ohio
Precision Grinding Wheel Co., Philadelphia, Pa.

Quigley Company, Inc., New York, N. Y.

Ransome Concrete Machinery Co., Dunellen, N. J.
Ramtite Co., Chicago, Ill.
Republic Steel Corp., Youngstown, Ohio
Rickmann & Rappe, Köln-Kalk, Germany
Riddell, W. A., Co., Bucyrus, Ohio
Roseville Pottery Co., Zanesville, Ohio
Ross-Tacony Crucible Co., Philadelphia, Pa.
Rundle Manufacturing Co., Milwaukee, Wis.
Rustless Iron Co., Ltd., Keighley, England

Safety Grinding Wheel & Machine Co., Springfield, Ohio
Salem China Company, Salem, Ohio
San Miguel Brewery, Inc., Manila, P. I.
Shenango Pottery Company, New Castle, Pa.
Simonds Worden White Co., Dayton, Ohio
Smith & Stone, Ltd., Georgetown, Ontario, Canada
Solvay Process Company, Syracuse, N. Y.
Southern California Gas Co., Los Angeles, Calif.
Spinks, H. C., Clay Co., Newport, Ky.
Square D Company, Detroit, Mich.
Standard Lime & Stone Co., Baltimore, Md.
Standard Sanitary Mfg. Co., Louisville, Ky.
Star Porcelain Co., Trenton, N. J.
Stark Brick Co., Canton, Ohio
Stauffer Chemical Co., Inc., New York, N. Y.
Steele, J. C., & Sons, Statesville, N. C.
Sterling Grinding Wheel Co., Tiffin, Ohio
Structural Clay Products, Inc., Washington, D. C.
Summitville Face Brick Co., Summitville, Ohio
Sur Enamel & Stamping Works, Ltd., Calcutta, India
Swindell Brothers, Baltimore, Md.
Swindell-Dressler Corp., Pittsburgh, Pa.

Taylor, Smith, & Taylor Co., Chester, W. Va.
Texas Mining & Smelting Co., Laredo, Texas
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Toyo Toki Kwaisha, Kokura City, Japan
Trenton Potteries, Trenton, N. J.
Twyfords, Limited, Stoke-on-Trent, England
Tyler, W. S., Company, Cleveland, Ohio

Union Electrical Porcelain Works, Inc., Trenton, N. J.
Union Française des Produits Refractaires, Paris, France
United Clay Mines Corp., Trenton, N. J.
United Glass Bottle Mfrs., Ltd., London, England
United States Gypsum Co., Chicago, Ill.
Universal Clay Products Co., Sandusky, Ohio
Universal Dental Co., Philadelphia, Pa.
Universal Sanitary Mfg. Co., New Castle, Pa.

Vereeniging Brick & Tile Co., Ltd., Vereeniging, Transvaal, South Africa
Verreries Souchon Neuvesel, Lyon, France
Vesuvius Crucible Co., Swissvale, Pa.
Victor Insulators, Inc., Victor, N. Y.
Vitrefrax Corporation, Los Angeles, Calif.
Vitreous Steel Products Co., Cleveland, Ohio
Vitro Manufacturing Co., Pittsburgh, Pa.

Wallace China Co., Ltd., Huntington Park, Calif.
Waltham Grinding Wheel Co., Waltham, Mass.
Washington Porcelain Co., Washington, N. J.
Wayne Laboratories, Waynesboro, Pa.
Western Brick Co., Danville, Ill.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Derry, Pa.
West Virginia Brick Co., Charleston, W. Va.
Wheeling Steel Corp., Yorkville, Ohio
Whitall-Tatum Co., Millville, N. J.

Youngstown Arc Engraving Co., Youngstown, Ohio

ROSTER CHANGES DURING AUGUST*

Personal

CONNER, HARVEY, General Delivery, Kingston, N. Y. (Alfred, N. Y.)

HATCH, EDWIN F., 174 Walden St., West Hartford, Conn. (Central Falls, R. I.)

HORNING, ROY A., Armstrong Cork Co., Lancaster, Pa. (Pittsburgh, Pa.)

HUNTING, EVERETT C., 1087 Arlington Ave., Plainfield, N. J. (Dunellen, N. J.)

JANATKA, RICHARD G., Kaolin, Inc., Spruce Pine, N. C. (Columbus, Ohio)

KIDNER, V. H., 333 Akron Ave., Mt. Lebanon, Pittsburgh, Pa. (Westerville, Ohio)

KNAPP, ERNEST W., 639 Main St., East, Hamilton, Ontario, Canada (Alfred, N. Y.)

KRIEGEL, W. WURTH, Ceramic Engineering Dept., N. C. State College, Raleigh, N. C. (Butte, Mont.)

LICHTENSTERN, FRANZ, 22, Thurlby Croft, Mulberry Close, London, N.W. 4, England (Czech-Protectorate)

MAUPIN, ADDISON, 302 E. Victory Dr., Savannah, Ga. (Olive Hill, Ky.)

MEEKA, EDWARD, 508 E. 3rd Ave., Lees Summit, Mo. (St. Louis, Mo.)

NESMITH, LEONARD C., 815 Doan St., Burbank, Calif. (Glendale, Calif.)

SOMMERVILLE, JAMES L., Owens-Illinois Glass Co., Columbus, Ohio (Alton, Ill.)

TREES, JACK E., 417 Lincoln Ave., Erie, Pa. (Muskegon Heights, Mich.)

WAGGONER, JACK H., 214 Rugg Ave., Newark, Ohio (Muncie, Ind.)

* Address in parentheses is the former address.

Vacation Time Is Over

We must now get out our individual starting blocks for the last heat of the 1939 race for better abilities to produce the best quality of ceramic ware.

Here is your count of those who have paid for their opportunity to race with you.

PAID MEMBERSHIP RECORD

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 20, 1936	1452	196				
December 22, 1937	1713	220	12	523	220	2688
December 19, 1938	1815	222	26	589	220	2872
January 21, 1939	1792	220	26	610	220	2868
February 18, 1939	1795	225	25	620	220	2885
March 30, 1939	1808	229	23	648	220	2929
April 18, 1939	1641	226	58	596	220	2741
May 20, 1939	1710	231	43	611	220	2815
June 16, 1939	1739	232	42	617	220	2850
July 17, 1939	1753	233	39	626	220	2871
August 22, 1939	1786	233	37	615	220	2891

Please note that the record as of December 19, 1938, shows that there are more who would join if they are asked to do so.

Your record of paid members as of August 22 last shows 85 more paid individuals, 19 more corporations, and 41 more paid subscribers than in August of last year. This shows a promise of an increase during the last half of the year.

CERAMIC HISTORY

FREDERICK CARDER, ARTIST AND GLASS TECHNOLOGIST*

By Alexander Silverman

The purpose of this article is to inform individuals in the field of glass technology and in the application of art concerning the accomplishments of a dear friend to whom many honors have come and who is, in the writer's estimation, the dean of American glassmakers. Frederick Carder is a high light among American glass producers.

Birth of a Potter

Frederick Carder, the son of Caleb and Annie Carder, was born in the village of Wordsley near Stourbridge, England, September 18, 1864. His father was associated with his grandfather in a pottery where salt-glazed stoneware was made. During his early training, Frederick was expelled from a school in Wordsley for throwing a slate at the principal. He admits that at that time he had a violent temper. He was next sent to a grammar school at Brierhill, where he got into a fracas with one of the other boys on the first day. The schoolmaster, who was a Scotchman and a strict disciplinarian, made it clear to Carder that if any fighting was to be done, he would see to it. Thereafter, the lad was careful in his conduct and devoted himself to his studies. These he found rather difficult, for it was the schoolmaster's idea that any education a boy got he had to dig up for himself so that he would not forget it. This master would put questions on the board which the students had to copy and for which the answers had to be prepared at home. Frederick's father fortunately had a good library and he was able to get much of the information. It would delight him when the master went over answers to the preceding day's questions and pointed out who was right and who was wrong.

At fourteen, Carder was head boy in the school and, having received all kinds of honors for his work, became "swell headed," thinking he knew everything. During his spare moments and particularly on week ends, he worked with clay, imitating some of the work which men were producing in his father's pottery. This took hold of him, and he begged permission to work in the pottery. The father felt that he should have more schooling and wanted him to enter Cambridge or Oxford, whose examinations he had passed. He did not insist, however, saying, "as you make your bed, you lie in it." Carder went to work in his father's pottery, thinking it would be great fun. His first job was to shovel coal for the kilns. This would have been all right for a week, but when it went on for nine months he began to realize what factory discipline from a stern parent meant. By this time all idea of play had been abandoned. Frederick began developing his artistic instincts by attending an art school evenings in Stourbridge, which was three miles away. There were no trolleys or motorcars in that day, and he had to walk after he had worked from six in the morning until six at night. His enthusiasm carried him through, and he attended not only the art school three times a week but later classes in the Dudley Mechanics Institute, an equal distance from his home, on two other nights. There he studied chemistry and metallurgy. During his stay at the pottery from his fourteenth to his seventeenth year, he went through every phase of the pottery industry from shoveling coal to tending the fires and kilns and making, setting, and drawing the ware. He participated in the glazing and thoroughly understood the drying from the softest state to white hardness. He could affix parts like handles and apply decorations, and he finally became an expert at the potter's wheel.

During his four years in the pottery, young Carder was already striving to improve the product. This inspiration came from his grandfather on his mother's side, John Wadelein, who had spent most of his life as manager of Foster's Iron Works, one of the largest in that region. The grandfather was well informed in chemistry and physics. He would tell his grandson about Wedgwood and other famous potters and presented to him a copy of Muspratt's Chemistry, which was the best introductory chemistry of that day. The other grandfather, George Carder, who owned the pottery, died and willed it to Frederick's father, Caleb, and his brothers, Henry and Joshua. For a number of years, there was trouble. One of the uncles, noting Frederick's continued experimenting, took a dislike to him, and eventually this became so acute that the lad left the pottery and obtained a position as designer in the glass factory of Stevens and Williams in Brierley, England.

Potter Becomes Glassmaker

Frederick Carder's going to Stevens and Williams came about through his ambition for further study. As previously stated, he attended art school at night and there became acquainted with a number of boys about his own age, who were, as he states, "fortunately better than I." Their fathers were in the glass trade, some in one department, some in another. Those who were interested in art were employed either as designers, engravers, or etchers, and the lad learned that the father of one of the students, John Northwood, had been working for twelve months at odd times to produce a copy of the celebrated Portland vase in glass. The Barberini vase of Roman times, about the beginning of the Christian era, is considered the finest piece of sculptured glass which has come to us from antiquity.

When Carder saw the copy which John Northwood made, he was immediately impressed with the possibilities of glass and decided to go into this field. Through the kindness of John Northwood, he was permitted to go down to Northwood's studio at Wordsley every Saturday after-

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Contribution No. 375 from the Department of Chemistry, University of Pittsburgh.

noon with the results of his experiments of that week. Northwood would criticize the work and give Carder an opportunity to model in wax around the Portland vase from one of Josiah Wedgwood's copies.

The introduction of carved cameo glass followed the sensation which came through the reproduction of the Portland vase in glass. Connoisseurs and buyers in Europe and America competed for cameo pieces and a staff of artists was kept busy. It was during this period that Carder applied for the position of designer at Stevens and Williams. He was filled with enthusiasm so great that he wanted to learn the business in a day and, if that were not possible, in a week. Coming from a pottery, with a full understanding of its methods, he mastered the art of glass blowing, cutting, and engraving in a short time—at least a short time as he then thought. He now admits, after fifty or sixty years in the field, that he does not know all that is to be learned. The proprietor of the glassworks, Joseph Williams, took a great interest in Carder and encouraged him at every turn to improve the artistic effects in his factory. Joseph William's aim was to turn out the most artistic products of all England.

After Carder had been in this position for about twelve months and was making appreciable progress, he continued the practice of going down to Northwood's studio each Saturday afternoon. He also resumed his attendance at the art school in Stourbridge three nights and two nights in the science school at Dudley. He was ambitious. With clay he modeled a frieze of the Parthenon in the art school, the first time that modeling was done in this particular school where most of the time had been devoted to drawing and painting. He was, of course, trying to produce something that would have a demand.

At the glass factory, where ruby and green were produced for flashing or casing, he saw the possibilities of other colors. At the suggestion of his grandfather, John Wadelein, he undertook experiments, trying any materials that he could get. The only information available in that day was obtained from Muspratt's Chemistry. The formulas for making and coloring glass were kept secret. There was also the item of expense. Carder thought that he could conduct his experiments in small crucibles, weighing his materials on a chemical balance. Fortunately, he learned about the Fletcher gas blast furnace and obtained a small furnace of this type in which he could make his melts in one or two hours. It was about this time that Abbé and Schott visited England to purchase several furnaces of the same type for their first experiments on optical glass. Carder had the furnace in operation daily, sometimes making as many as four melts per day. Many new colors and effects resulted. At the same time, he was employed as a designer in the factory and made models for new molds that were required. There was no machine in the factory. The molds had to be purchased outside. He next bought a lathe and began to make not only the models but the molds themselves for goblets and other ware. Naturally, with designing, making the models, turning out the molds, and experimenting on colored glasses, he was intensely busy, and yet he continued studying art and science evenings for some years.

Exhibit in Metropolitan Museum of Art, New York, N. Y.

Rewards

This conscientious application to study and work brought its returns. He entered a government national competition for all schools of art in England, Scotland, and Ireland, which was held in South Kensington, London, and was awarded the gold medal for the best design submitted and a traveling scholarship. This national scholarship was awarded to exceptional students in arts and sciences and corresponds to the present Beaux Arts scholarships of the United States. Carder had made an agreement with Stevens and Williams for five years, and the company would not release him, so that he could not take the scholarship. This incident changed his whole life, for it was his sole ambition to become a sculptor.

Losing the scholarship, he devoted more time to the study of glass and at the same time began to develop his ability as a teacher. Because most workmen in the factory could not understand a drawing, he conducted evening classes and taught them how to draw and interpret their work. The classes were so successful that they were transferred to the Department of Science and Art of London, South Kensington. Later they became a full-fledged school of art. He inspired his students, for whom his own enthusiasm became contagious; as a consequence of his success, however, a jealousy developed on the part of his first critic and teacher, John Northwood. Northwood had obtained the position as art director at the factory. At first, he assumed a lukewarm attitude toward Carder, and later he openly antagonized him. Although this was unpleasant for Carder, it was fortunate for us, for eventually it resulted in his coming to America.

Carder the Teacher

Owing to his success in the school of art in South Kensington, Mr. Carder was approached by Thomas Turner, Director of Education of the South Staffordshire County Council, and also by the Director of the City and Guilds of London Institute to conduct classes in glass manufacture. This he did. He not only enjoyed a good enrollment, but to his surprise found glass masters of the district coming to see what was going on. He continued with the school of art in Wordsley and with his classes in glass manufacture for about ten years.

His lot with Stevens and Williams was not a happy one because of the machinations of his former friend, Northwood. The latter's son was brought into the factory, and from the day this lad entered, things went from bad to worse for Carder. He originally had been promised that he would have an interest in the firm. He saw now that he would have to play second fiddle to young Northwood or leave.

It was about this time that Graham Balfour, the new Director of Education of the South Staffordshire County Council, asked Carder to go to Germany and Austria to make an exhaustive study of glass there. Mr. Carder accepted the invitation. Equipped with letters of introduction to British ambassadors in Berlin and Vienna, he was able to visit all of the factories he had in mind, although at that time the secrecy in glass manufacture rarely permitted a visitor to enter a plant. Being introduced as a teacher of art facilitated his admittance, and he was given every courtesy possible.

Upon his return, he submitted a report to Mr. Balfour, who requested that it be printed and distributed to the glass trade of England. Mr. Carder was invited to give several lectures regarding his trip in the Wordsley School of Art. The auditorium was packed. There was not even standing room, and he was generously applauded.

Apparently, Mr. Carder was still associated with Stevens and Williams, for after his tour Joseph Williams asked him to meet some of the American buyers and ascertain their methods. The consequence was that the company obtained 75% of the American trade, as compared to about 5% when Carder had first joined them. Mr. Carder found that many of the buyers were uninformed. As he states, "they were so absorbed with their own importance that they failed to grasp the fine points in connection with purchases." Those who sought and heeded Mr. Carder's advice improved their business appreciably as a consequence. Others, who were apparently unwilling to learn, suffered from the competition of the more discriminating American buyers. Mr. Carder was under the impression that the Americans paid more attention to card indexes and classification—in other words, to system—than to fine art discrimination; he brings this out forcefully in a comment concerning one of our largest automobile plants which he visited many years later. He states, "After looking at their system and the monotonous life each worker lives in such a factory, I came away with the thought that the entrance gate to this plant should bear a sign, 'Abandon hope all ye who enter here.' To watch these men, some standing and some sitting, putting a screw here and a bolt there, the same monotonous thing day after day, made me think of Sisyphus, legendary king of Corinth, who was condemned in Hades to the constant task of rolling uphill a huge stone which continually rolled back down again." In other words, Carder, the artist, objected to having machines dominate human beings.

To America, First Impressions

In 1903, Frederick Carder finally decided to cast his lot with the "Yankees," whom he still delights in joshing just to start an argument. When he told Joseph Williams that he was planning to come to America, the latter's face, in the vernacular, "went red." He wanted to know why Carder wished to leave and was informed that he hoped for better prospects in America. Williams immediately offered to double his wages and Carder refused. He offered to triple them, and his offer was again rejected. This should prove a lesson to all who read the present biography. Employers only too often fail to show their appreciation of their employees by increasing their wages or salaries from time to time when they deserve increases. Carder's employers deserved what happened, for he worked for them as hard as if the business had belonged to him personally. They killed his ambition and his interest there by failing to recognize him. Mr. Carder's greatest regret was the necessity of resigning as Head of the School of Art and from other pleasant connections which he had made.

After making his preparations, he traveled to Liverpool by rail. On this trip, he met an old friend who had accumulated a fortune and who tried to induce him to remain in England and start a factory of his own. The decision to come to America, however, was made, and he abandoned the land of his birth.

A comment of Mr. Carder's concerning his foreign-trade relations while in England might interest Americans of the present generation, in which our business fluctuations are associated with the political régime. Carder's employers had an extensive foreign trade with Russia, South America, Mexico, Australia, and, in fact, they exported to all parts of the civilized world as well as to America. During the Cleveland administration, the tariff on glassware was dropped from 60 to 35%. Carder thought that this would result in an increased American trade. The first American who came over that year was James Caldwell of Philadelphia. He looked around the show rooms, asking the prices of various articles and finally commented, "They are very nice, but I am not going to buy a thing." When asked why, he answered, "We do not know which way the cat is going to jump," and he predicted further that no other Americans would buy until there was a change in the administration. Mr. Carder states that the prediction proved correct for during the time of the lower tariff Stevens and Williams sold only about one tenth of the amount normally exported to America in previous years. With the advent of the McKinley administration and the higher tariff, orders immediately poured into England again.

Another comment of Mr. Carder's in connection with economics is worthy of consideration by Americans of the present day. He remarked about the British loss of South American trade as a consequence of a German invasion primarily through the establishing of German banks in South American countries. This enabled the buyers to make their payments through their local banks instead of advance demand payments, which are often necessary without such facilities.

The perspective of American trends, which has just been discussed, did not deter Mr. Carder, for he sailed from Liverpool as a tourist on the S. S. Oceanic on February 25, 1903. He had been commissioned to report to the South Staffordshire Education Board on the glass trade in the United States, a report similar to that on Germany and Austria he had made the year before. After a rough voyage, he landed in New York.

In America

Frederick Carder came to America in 1903. His first impression of New York was queer. He felt that Paul Gustav Doré, the French painter and illustrator, must have seen New York before he prepared his sketch of Hades with tall buildings and a devil peering out of every window. Carder still has the same feeling every time he is on a ship either leaving New York or returning. About his arrival in New York, where he went to the old Astor House, he says, "What a city, dirt galore and smells; one wants to place a clothespin on his nose." After a trip around New York on a sightseeing bus, he crossed on a ferry to the Erie Station and traveled to Corning, New York. He comments about his disappointment in seeing nothing but wooden houses, whereas in England brick and stone construction predominated. He arrived in Corning after a long and tiresome journey, and he landed in this little town, about a thousand feet above sea level, finding the ground frozen and covered with snow. Some of his early comments about Corning are amusing. On inquiring how long the winter lasted, and being told seven months, he was reminded of the saying of an English friend who referred to the United States frequently as "a place where six months of the year you were roasted and toasted, and the other six months you were up to your middle in snow." He visited various factories in Corning in a buggy, and he commented, "Oh, what roads!"

Vase engraved in 1930.

Completing his preliminary survey of Corning, Carder came to Pittsburgh with a letter of introduction to the Mellon Bank. He was astonished to see a city noted for iron and steel "lined with wooden poles in a sorry state of

drunkenness upon which were fastened wires for the telegraph and trolley lines." He commented, "I had seen dirt and smoke in the Black Country, so-called, in Staffordshire, England, but Pittsburgh at that time beat anything that I had seen before." He called at the bank and met Andrew Mellon, who gave him letters of introduction to a number of glass manufacturers. He also visited most of the steel plants. Before coming to America, he was impressed with the Siemens regenerative furnaces, which he had seen on his visit to Austria in 1902, and he determined to use gas as a fuel in one of these furnaces when he organized his company. He had obtained blueprints from Siemen Brothers in London and brought them with him. In Pittsburgh, the late Harry L. Dixon, one of the best pioneer furnace builders in the United States, immediately placed a damper on the regenerative furnace idea by estimating that it would cost about $50,000 to build one.

Sculptured art lamp.

Before leaving England, Colonel William Webb, a member of Parliament, who traveled extensively in the United States, said to Carder, "If you decide to stay in the United States, by all means locate in New York State, for that is the only State which at all resembles England." After trips to other cities, including Washington, Carder decided to return to Corning and there, with Thomas G. Hawkes, he organized the Steuben Glass Works to manufacture blanks for cutting and engraving and to engage in the production of artistic glass, finished entirely "at the fire." Before starting the factory in an old building which had been used for a machine shop and foundry, they conferred with Amory Houghton of the Corning Glass Works, which plant already had "ten chimneys and manufactured electric light bulbs, lanterns, and lenses for railroads." Mr. Hawkes seemed anxious to assure Mr. Houghton that the Steuben Works did not intend to make anything in competition with the Corning plant. During all the years that Steuben was in operation, this bargain was maintained.

When Mr. Carder mentioned to Mr. Houghton that he intended to build a gas furnace of the regenerative type and commented that the American furnaces were a hundred years behind the times, Houghton's only comment was "Is that so?" Carder soon realized that excessive cost made his new furnace impossible, and he had to content himself with one of the older types. He states, "We were in trouble all the time for the furnace required too much watching. If the wind blew in a particular direction, the draft of the chimney was retarded, owing to a nearby hill."

His next job was to find workmen who could make the products he wanted. He employed a shop of Germans and two other shops of Swedes, who had previously made blanks for cutting in a factory in New Jersey. He found the workmen unqualified for their trade and, after putting on a few more shops, he decided again to become the teacher. After many months, the workmen began to see what Carder was driving at and, he states, "eventually they became as fine a lot of workmen as could be found anywhere." In addition to blanks for cutting and engraving, Steuben started to make vases and bowls in various colors. A variety of artistic electric lampshades was placed on the market and became popular. With the profit from these, more land was purchased, and finally a sixteen-pot regenerative furnace was built. This increased variety and production.

Frederick Carder's policy in the production of artware had been predetermined not only by his own experience in England but through his thorough study of the trend of art there. It seems that when John Northwood produced his copy of the Portland vase around 1875 to 1880 and placed it in the Paris Exposition, it created a sensation among ceramic artists.

Emile Gallé, who had been producing furniture and some pottery, began working with relief decorations on glass, creating landscapes and flowers through the application of etching and color. Daum Freres at Nancy began producing etched and cameo effects, though perhaps they were less artistic than Gallé's. In 1900, Gallé held an exhibit in Paris which was a revelation to Carder. At this Exposition, there was also a collection of glass (from Louis

Tiffany in New York) showing metallic iridescence. This created a sensation. The effects had been produced for Tiffany by Arthur Nash, formerly with Edward Webb and Sons in the White House Glass Works of Wordsley, England.

Before seeing these effects, Carder had already been experimenting for years on the production of metallic iridescence, and in 1904 in Corning, New York, he announced his "Aurene" glass, iridescent in a great variety of beautiful colors. The product met with instant response and there was a large output for a period of twenty-five years. The surface layer necessary for iridizing could not be applied to the older glasses which had been produced. A new foundation glass was made whose coefficient of expansion would take the outer layer which received the art treatment. This eliminated the breakage previously encountered with the original foundation glasses.

Then came Carder's first commercial competition in the United States. Several men, who flattered him by saying that he was making 75% of the decorative lighting shades in the United States, stated that they wanted to go into business and that they were representing the General Electric Company of Cleveland. They promised not to undersell the market, and they obtained photographs and price lists of the Steuben products. When they began manufacturing, they approached Mr. Carder's own customers and offered to cut his prices 25%. After two years, they ceased manufacturing altogether and dumped the remainder of their stock on the market at 25 cents per unit. Mr. Carder states that this act ruined a trade which would have continued for many years, if unscrupulous competition had not developed. This experience unquestionably influenced Mr. Carder's attitude toward competitors, for he has rather consistently refused to display his ware to any of them. He has frequently commented to the writer, "The moment I put something decent on the market, a competitor copies it and sells a cheap imitation."

Mr. Carder developed opaque glass for semi-indirect illumination, and his "Calcite" glass was the result. It won immediate favor with illuminating engineers. Orders for bowls of various shapes and designs, ranging from 10 to 28 inches in size, came from all parts of the country. Semi-indirect illumination is still in favor.

The cheap competition, however, continued and inexpensive products resembling the finer ones were produced. The principle of "keeping up with the Joneses" is one which probably will never disappear, and if the small wage earner can buy something for his home which resembles a deluxe article in his employer's residence, he is likely to do so. In connection with cheap competition, Mr. Carder quotes the late President McKinley, who in 1890 said, "I do not prize the word 'cheap.' It is not a word of hope; it is not a word of comfort; it is not a word of cheer; it is not a word of inspiration. It is the badge of poverty. It is the signal of distress. Cheap merchandise means cheap men, and cheap men mean a cheap country." In other words, Mr. Carter claims that the opinion of most sound business men is that a good article at a fair price is the most wholesome thing for a country.

With the advent of the motor car, attractive magazines, and mail advertising, a somewhat better appreciation of artistic work resulted, especially for glass, and the American market for the attractive, the beautiful, and the fine improved. Then in 1914 the World War started in Europe. Importers could not obtain goods from abroad. The demand for fine ware in America increased still further. Mr. Carder had just booked an enormous lot of orders which, as he said, would have kept him busy for a period of three years when "some blatant banker from New York went through the country preaching essential

Engraved goblet.

against nonessential industries." Carder always made his contracts for raw materials and fuel for a period of at least one year at a time. The Government placed an embargo on the use of materials for nonessential industries and, as he states, he was left "high and dry" with three years of orders to fill and with nothing to produce the ware.

When he saw that the situation had really become acute, he decided to make some essential goods for the Government and on writing to Washington was awarded a contract for glass equipment for gas warfare. He was unable, however, to get materials except at an exorbitant price. He then contacted the Corning Glass Works to see if he could make anything for them in the essential lines, and he finally turned his factory over to them for making bulbs.

This arrangement culminated in 1918 in the amalgamation of the Steuben Glass Works with the Corning Glass Works. The Steuben Division until recently was operated as a separate unit with Mr. Carder in charge. He is now art director of the new Corning Corporation.

Mr. Carder's Family

In 1887, Mr. Carder married Annie Walker of Dudley, England. Members of The American Ceramic Society who were on the European tour in 1928 will recall this devoted couple, who were celebrating the forty-first anniversary of their marriage on the Tuscania. Recently, they celebrated their fiftieth anniversary. The Carders live in Corning. They had three children, Stanley (deceased), Lieut. Cyril, who was killed in the World War, and a daughter, Gladys (Mrs. Gillette Wells). There are two grandsons, Carder Wells and Gillette C. Wells, Jr., both graduates of Williams College.

Clubs, Societies, and Honors

Mr. Carder is a Thirty-Third Degree Mason, and he is President of the Rotary Club of Corning, New York, and of the Board of Education. For seven years, he was president of the Country Club and for ten years of the City Club.

He is a member of the Architectural League of New York, the American Chemical Society, Illuminating Engineering Society, American Federation of Arts, and American Association for the Advancement of Science.

He is a Fellow and Honorary Member of The American Ceramic Society, a Fellow of the Royal Society of Arts of London, and a Fellow of the Society of Glass Technology of England. Mr. Carder is a member of the Advisory Committee of the Metropolitan Museum of Art in New York. In 1925, he was a delegate on the Hoover Commission to the Paris Exposition.

The creations of Frederick Carder, a few of which are illustrated here, constitute a precious art museum in themselves and, as a whole, have never been equalled by the products of any other single individual for their variety, attractiveness, originality, and intrinsic value.

National competition in schools of art in Great Britain and Ireland resulted in Mr. Carder's being given an art glass teacher's certificate in 1892, an art master's certificate for exceptional qualification in 1893, ten national book prizes between 1881 and 1893, a silver medal for sculpture in 1890, and a bronze medal for a statuette in 1891. In 1889, he was awarded the three-year scholarship for study in Paris and Rome, which he had to refuse because his employers would not release him from a five-year contract. In 1889, he was also awarded the first place in Great Britain among thirty candidates who competed in a modeling contest from life in South Kensington under Professor Lauteri. In 1893, his sculptures were admitted to the Royal Academy. His American honors have included the Fuedsom Medal of the Architectural League, awarded in 1927, and the Charles Fergus Binns Medal of The American Ceramic Society, awarded in 1933.

A Request and an Appreciation

Mr. Carder's extensive and precious experience in the art and technology of glassmaking makes him an individual who is the custodian of valuable information which should be published and become available to posterity. The writer knows that Mr. Carder has already made notes on much of this material, and it is hoped that he will take the time to publish a volume on glass production.

The writer concludes with a bit of significant doggerel written about Mr. Carder by one Bill Leavitt in 1936. It indicates that not only we, his associates, prize him, but that his workmen look upon him with equal favor.

"Great moments come to every man,
A fleeting second when he can
Attain such fame that folks proclaim
The very mention of his name.

It matters not his dwelling place,
If by his skill he sets the pace
Or leads his guild in things they do—
As witness—'Gaffer' Bonique.

In sixteen hundred thirty-nine,
He fashioned Sandwich glass sublime,
Attaining skill which folks opine
The very greatest of his time.

Three centuries since this 'Gaffer's' start
We find his very counterpart
Creating works of art anew,
Out-gaff'ring 'Gaffer' Bonique.

Intaglio and flashed designs
Acid-etched and freehand lines
Proclaimed him from the very start
The greatest master of his art.

'Gaffer' Carder is the name
Of him who has attained such fame;
Who wrought with fire and loving care
Incomparable Steuben ware.

Our praise we add to Frederick's laurel
In verse, which *we* wish might be oral,
From one who strives to reach the top
As 'Gaffer' of a small lamp shop."

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

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SUGGESTIONS FOR HONORARY MEMBERSHIPS

The Committee on Honorary Membership requests suggestions from members of The American Ceramic Society. If you have someone in mind who should be considered as an Honorary Member, send accurate information, covering the following points to the Chairman, Alexander Silverman, University of Pittsburgh, Pittsburgh, Pa.:

(1) Full name and address.
(2) Date and place of birth.
(3) Names of parents with scientific and cultural background.
(4) Education, with institutions attended and degrees obtained (with dates).
(5) Positions held from time to time with titles and dates.
(6) List of publications with full titles and specific journal references.
(7) Membership in scientific societies.
(8) Honors received.
(9) Information concerning wife and children, if individual is married.
(10) Recent photograph of the nominee.
(11) Your personal letter of recommendation.

NECROLOGY

JOHN M. MANOR TAKEN BY DEATH

John M. Manor, vice-president of the Consolidated Feldspar Corporation, died suddenly of a heart attack at his home on 1009 Avondale Street, East Liverpool, Ohio, March 1, 1939. Although he had been in failing health for about two years, he carried on his business activities until the time of his death. He had just returned from a two-day business trip at the main offices of the Consolidated Feldspar Corporation in Trenton, N. J.

Mr. Manor was born in East Liverpool on July 4, 1869. He learned the printing trade, and before he was fourteen years old he went to work as an office boy for Golding & Sons Company, flint manufacturers of East Liverpool.

Mr. Manor became bookkeeper and superintendent of the Company and was named head of the industry when M. E. Golding, the owner, retired. When the local plant was acquired by the Consolidated Feldspar Corporation a few years ago, he was made vice-president and remained in charge of the East Liverpool office.

Mr. Manor became a member of the board of trustees of the East Liverpool City Hospital in 1907 and served until his death. He was a member of the admission committee for twenty-five years, and he also served on the grounds committee.

Mr. Manor was one of the organizers of the East Liverpool Chamber of Commerce, and he had been a member of the board of directors since its inception in 1915. He was also first vice-president and chairman of the transportation committee several years and substitute national

John M. Manor

councillor from the local chamber to the United States Chamber of Commerce.

Mr. Manor was an associate member of the United States Potters Association, which he served for several years as a member of the transportation committee.

The Specialty Glass Company was brought to East Liverpool through Mr. Manor's efforts, and he was president of the Company during the time that its plant was operated near Patterson Field, meanwhile maintaining his connection with Golding & Sons Company.

Mr. Manor had been a member of The American Ceramic Society since 1906.

NOTES AND NEWS FOR CERAMISTS

PORCELAIN ENAMEL INSTITUTE FOURTH ANNUAL FORUM

Plans for the Fourth Annual Forum of the Porcelain Enamel Institute are nearing completion, according to Frank E. Hodek, Jr., of the General Porcelain Enameling & Mfg. Co., Chairman of the Forum Committee. The Forum will be held October 18, 19, and 20 at Ohio State University, Columbus, Ohio.

Following registration on Wednesday morning, October 18, a general session is scheduled for the afternoon. On Thursday morning, the Forum will divide into two divisional sessions, one on cast iron and the other on sheet iron and hollow ware. Thursday afternoon, the cast-iron divisional meeting will continue, the hollow-ware group will attend another session, and a third division will discuss architectural enameling.

The general sessions on Friday will cover a variety of subjects designed to furnish valuable information to practical shop men in all branches of the industry.

Wednesday Afternoon, October 18

Presiding: R. M. King, Ohio State University

Address of Welcome and Response

E. C. Aydelott of the Benjamin Electric Mfg. Co. will conduct the "Symposium on Fine-Ground Enamels" and will be aided by other contributors. To assure a lively discussion of this important subject, all interested enamelers are urged to prepare material gathered from their experience to contribute to the symposium. The same invitation applies to other subjects where an informal interchange of opinions has been planned in place of set papers.

Thursday Morning, October 19

DRY-PROCESS CAST-IRON SESSION

Presiding: F. B. Mahoney, Humphryes Mfg. Co.

(1) Sunflowers and Powder Blisters
(2) Fineness of Enamels
(3) Cast Iron for Enameling Purposes

SHEET-IRON AND HOLLOW-WARE SESSION

Presiding and Conducting Symposium: B. T. SWEELY, Chicago Vitreous Enamel Product Co.

(1) Use of Softened Water in Cleaning and Pickle Room Practice
(2) Drawing Compounds
(3) Health Hazards and Their Control in Pickling Operations

Thursday Afternoon

DRY-PROCESS CAST-IRON SESSION

Presiding and Conducting Symposium: HOMER F. STALEY, Metal & Thermit Corp.

Symposium on Dry-Process Enameling

ARCHITECTURAL SESSION

Presiding: P. B. MCBRIDE, Porcelain Metals Corp.

(1) What the Jobbing Shop Must Do to Handle Architectural Work
(2) The Architect Looks at Porcelain Enamel
(3) Development of Specifications to Meet Building Code Requirements

HOLLOW-WARE SESSION

Presiding: E. C. DEXHEIMER, National Enameling & Stamping Co.

(1) Some Observations on a Settling Test to Determine Fineness of Porcelain Enamel
(2) Effect of Variation of Annealing Between Draws
(3) Control of Enamel Application

Friday Morning, October 20

Presiding: J. B. SIMON, Westinghouse Elec. & Mfg. Co.

(1) Use of Fuel Oil in the Enameling Field
(2) Presentation of New Ball-Mill Bulletin
(3) Ball-Milling Practice
(4) Proposed Tentative Standard Test for Impact Resistance

Friday Afternoon

Presiding: J. J. CANFIELD, American Rolling Mill Co.

(1) Inspection, Checking, and Field Problems of Porcelain Enameled Products
(2) Welding for Enamel Parts
(3) Forum Plans for 1940

PENNSYLVANIA STATE COLLEGE DIVISION OF MINERAL INDUSTRIES EXTENSION

Ceramics Extension, 1938–1939

The curriculum in ceramics extension consists of three years of work for which one textbook has been prepared for each year. The first year consists of a general preparatory course covering fundamentals of mathematics, physics, chemistry, fuels, and combustion. The second year of the curriculum deals with the geography, geology, mineralogy, extraction, preparation, and beneficiation of all ceramic raw materials.

This work is common to all ceramic-extension students. During the third and final year of the studies, an option is available depending upon the particular industry in which the student is engaged.

It is planned to have four terminal third-year courses dealing with the following subjects for which a textbook will be prepared in each instance. They are (*a*) Heavy Clay Products and Whiteware, (*b*) Refractories, (*c*) Glass, and (*d*) Enamels. Books for subjects (*a*) and (*b*) are in preparation. Book (*a*) is expected to be ready for third-year classes starting in October, and book (*b*) will be completed within the school year. Book (*c*) will not be prepared by this Division at the present time, but classes interested in glass will use a standard textbook, Modern Glass Practice, by S. R. Scholes. Book (*d*) is scheduled for preparation by this Division in the near future.

All classes are organized on the basis of 120 hours per year. These classes meet usually two hours per night, two nights per week for 30 weeks. Students are awarded a certificate worth eight points toward an industrial diploma upon the completion of each year of the work. When the student has completed satisfactorily the three-year curriculum in any extension work offered by this Division, he is awarded an extension diploma in the curricula he has completed.

During the extension class year just closed, three first-year classes, seven second-year classes, and one third-year class were organized in ten class centers in nine counties of the State with an enrolment of 171 students. Additional classes will be formed in other class centers as requests are received by this office from groups who wish to undertake studies in this subject.

The net annual cost per student per year in classes operated under public supervision and control is $2.50, which is the price of his textbook. In company-operated or the so-called "captive" classes, the pro-rated cost of the teacher's salary is additional. The latter arrangement may be alleviated through company action. It has been found to be encouraging to the student for the company to remit all or part of his instruction cost if the student passes the course. Under public supervision and control, the local school board, the State, and Federal Government share the instruction costs equally.

—H. B. NORTHRUP, *Director*
Mineral Industries Extension

NATIONWIDE ART EXHIBITION

An art exhibition will be held this autumn under the auspices of the Artists Guild, Inc., known as the First Annual Artists Guild Award and Traveloan Exhibition. The Guild will offer professional artists in all parts of America an opportunity to make new contacts with the users of commercial art.

The two winning entries will receive a silver plaque and $100 each without restrictions. Two additional awards of $400 each are offered by the Research Laboratories of M. Grumbacher, New York, N. Y.

The contest starts immediately and will be open to any professional artist in the United States. Entry blanks are available at professional art schools, museums, and artists' material dealers, or they may be obtained from the Artists Guild, 9 Rockefeller Plaza, New York, N. Y.

The Artists Guild is just what the name implies, a guild of craftsmen of recognized ability and standing in the field of commercial art. Founded in 1920, the Guild is an association composed exclusively of free-lance artists and designers in the advertising and illustrating field. Its avowed purpose is to elevate business and artistic standards and to standardize practices in an essentially unbusinesslike profession so as to make it possible for artists to practice their craft as independent men.

GROW BY GETTING MORE NEW MEMBERS

AMERICAN FOUNDRYMEN'S ASSOCIATION TO HOLD FORTY-FOURTH ANNUAL CONVENTION IN CHICAGO

The American Foundrymen's Association will hold its Forty-Fourth Annual Convention at the Palmer House in Chicago, Ill., May 6–10, 1940. A major exhibit of foundry equipment and supplies will also be on display in the exhibit halls of the International Amphitheater of the Union Stock Yards and Transit Company. The exhibition will open at noon on May 4 and continue through the evening; it will be closed Sunday and reopen concurrently with the Convention on May 6. The daytime sessions will be held in the meeting rooms of the Stock Yards Inn, Saddle and Sirloin Club, and the Amphitheater; evening meetings will be held at the Palmer House.

NEW APPOINTMENTS

Theodore E. Pochapsky, a graduate of Ohio State University, has been appointed to the research staff of Battelle Memorial Institute, Columbus, Ohio. Mr. Pochapsky, a physicist, has been assigned to the ceramic division.

John Steencken has been appointed as service representative and Frederich Woltil as a member of the laboratory staff at the Porcelain Enamel & Mfg. Co., Baltimore, Md. After graduating from the University of Illinois, Mr. Steencken was employed by the Wolverine Porcelain Enameling Company. Mr. Woltil has been associated with the Chicago Vitreous Enamel Product Co.

ARCHITECTURAL PORCELAIN ENAMEL

Representatives of the iron and steel companies that manufacture enameling sheets met in Columbus, Ohio, July 18, to discuss the development of the market for architectural porcelain enamel.

Reports of interviews with many prominent architects read at the meeting indicated that porcelain enamel is the most promising of the newer architectural materials. Charts of sales showed that 1939 shipments were well ahead of both 1937 and 1938.

The committee will meet again in the early fall to consider a plan of co-operative action which will be ready at that time. Those present were H. V. Mercer, Ray Dadisman, and Paul Weinman, American Rolling Mill Co.; C. H. Fitzwilson and Harold Skemp, Carnegie-Illinois Steel Co.; S. E. Eldridge, Newport Rolling Mill Co.; C. B. Pharo, Jr., Republic Steel Corp.; J. M. Tuthill, Youngstown Sheet & Tube Co.; R. M. King, Ohio State University; and C. S. Pearce, Porcelain Enamel Institute. J. H. Wilson of Armco represented the Building Code Committee of the American Iron and Steel Institute at the meeting.

FIBERGLAS DUST-STOP FILTER

The introduction of a new type dust-stop air filter for industrial and commercial use, utilizing the new fiberglas material which is now employed extensively for air-cleaning purposes, has been announced by the Owens-Corning Fiberglas Corp., of Toledo, Ohio.

The new filter is one inch thick and is to be used with one or more like filters in series. It has been designed to provide operating economy in applications which are supervised carefully and where the filter is changed at frequent intervals. It is an adhesive-coated, impingement type of filter, noncleanable and designed to be replaced when filled with dust.

H. J. BABCOCK WITH FERRO COMPANY

H. J. Babcock has joined the engineering staff of the Ferro Enamel Corporation of Cleveland, Ohio. Mr. Babcock has served as electric heating specialist for the Tennessee Power Company for the past six years.

PENNSYLVANIA'S GOVERNOR JAMES APPOINTS R. P. BROWN

Richard P. Brown, who was recently appointed by Governor Arthur H. James to be the first Secretary of the new Department of Commerce of the Commonwealth of Pennsylvania, is the former president and now chairman of the board of the Brown Instrument Company and vice-president of Minneapolis-Honeywell Regulator Company.

Richard P. Brown

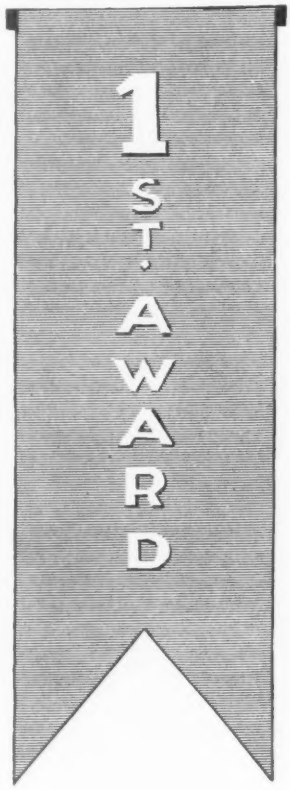
Mr. Brown has been interested for some years in the industrial development of Pennsylvania with the objective of increasing the number of jobs in private industry and thereby reducing the relief load and in turn the taxes necessary to support those on relief.

The new Department of Commerce is not only to aid Pennsylvania's industries in their successful expansion and development, but it was also authorized by the Commerce Law to recommend to the Pennsylvania Legislature future legislation that can be of help to Pennsylvania industries.

Mr. Brown's past business training of thirty years devoted to the manufacture of measuring and controlling instruments for use in industry should stand him in good stead in his new position as Secretary of Commerce of Pennsylvania.

GLASS IN HOME FURNISHING

The use of glass as a structural and decorative material in home furnishing, including new fiberglas fabrics, is the theme of an exhibit featured by R. H. Macy & Co., New York, N. Y., in coöperation with the Libbey-Owens-Ford Glass Company and Corning Glass Works. Unusual color themes are used in each of the six rooms. Green, golden, and clear plate glass are used in combination with white fiberglas in plain and patterned designs.



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You can bring down, at the A.S.T.M. rate of heating, any cone up to and including Cone 39 with this furnace.

P. C. E. FURNACE

American Refractories Institute Type

Scientifically designed combustion chamber is served by four burners arranged tangentially on a manifold of high-temperature cast alloy. The air-gas mixture is fed by direct-driven, rheostat-controlled motor. Blower is equipped with a shutter box permitting adjustment of air from 200 to 4500 cu. ft. per hour at pressure of 5″ of water.

Cone 34 can be brought down with gas alone, Cone 39 with the addition of small amounts of oxygen.

Approximate gas consumption only 153 cu. ft. per run on natural gas, 1000 B.t.u.; only 55 cu. ft. of propane gas, 2700 B.t.u.

WRITE FOR BULLETIN 460

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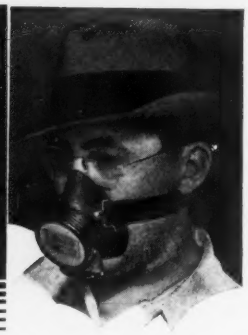

WILLSON Dustite Respirators are recommended for such dusts as grain and straw, paper, cleaning powders, tobacco, etc., not classified as pneumoconiosis producing by the U. S. Bureau of Mines. They protect against physical discomfort, and lowered resistance to colds and other infections caused by irritation of the nose, throat, and bronchial tubes.

Employees will gladly wear them, for they are light in weight, and the adjustable rubber facepieces conform comfortably to the face. The No. 55 Dustite Respirator, illustrated above, employs a mechanical diaphragm type exhalation valve and improved filter disc.

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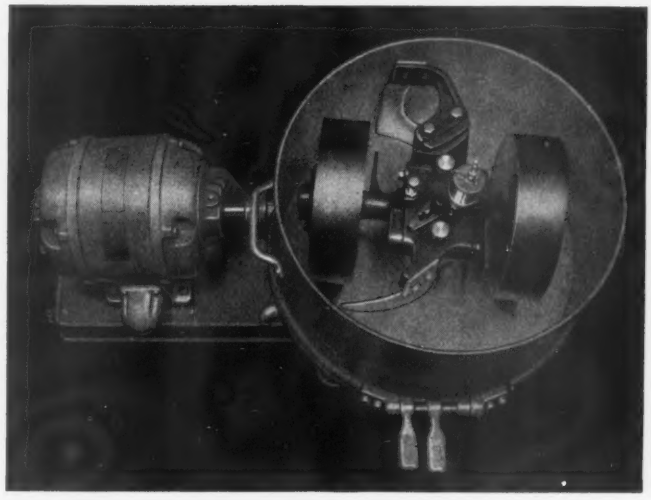

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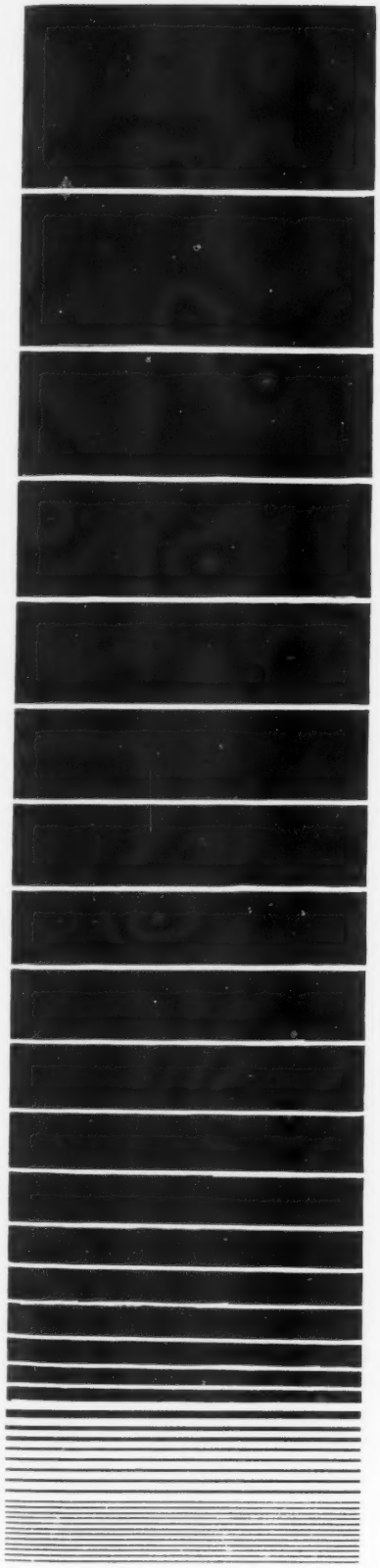

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